CRC®-15R

RADIOISOTOPE DOSE CALIBRATOR

OWNER'S MANUAL

Capintec, Inc.
Sales and Marketing
and Customer Support
6 Arrow Road
Ramsey, NJ 07446
Phone (800) ASK-4CRC
Fax (201) 825-1336

Capintec, Inc.
Service Center
540 Alpha Drive
Pittsburgh, PA 15238
Phone (800) 227-6832
Fax (412) 963-0610

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WARRANTY

DECLARATION OF CONFORMITY

PREFACE

Thank you for purchasing the Capintec, Inc. CRC®-15R Radioisotope Dose Calibrator. Every effort has been made to insure that the information in this document is complete, accurate, and up-to-date. Capintec, Inc. assumes no responsibility for the results of errors beyond its control. Mention of products manufactured by other companies does not necessarily constitute endorsement by Capintec, Inc.

Please address any comments pertaining to this manual to:

CAPINTEC, Inc.
540 Alpha Drive
Pittsburgh, PA 15238
Phone (412) 963-1988
Fax (412) 963-0610

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SYSTEM DESCRIPTION

The basic CRC®-15R Radioisotope Dose Calibrator consists of the following:

- Display Unit
- Chamber
- Power Cord
- Printer (optional)

YEAR 2000 COMPLIANCE

The CRC®-15R measurement systems contain information technology that accurately processes date and time data between the years 1999 and 2000. These products, when used in combination with products purchased from other manufacturers whose products properly exchange date and time information, will accurately process the date and time. All future products are committed to meeting the same Year 2000 compliance.

MEDICAL EQUIPMENT SAFETY CLASSIFICATION

- CLASS I EQUIPMENT energized from an external power source.
- TYPE B EQUIPMENT with no applied parts to the patient.
- Ordinary EQUIPMENT without protection against the ingress of water.
- Suitable for CONTINUOUS OPERATION.
- NOT suitable for use in an OXYGEN or a FLAMMABLE ENVIRONMENT.

ELECTROMAGNETIC INTERFERENCE POTENTIAL

This equipment complies fully with interference immunity requirements of the standard EN 60601-1-2 “Medical electrical equipment: Part 1: General safety requirements; 2. Supplementary standard: Electromagnetic compatibility”.

This equipment generates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to nearby devices. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference, the user is encouraged to try to correct the interference by one of the following measures:

- Increase the separation between the equipment and the affected device.
- Plug the unit into an outlet on a circuit different from that to which the affected device is connected.

If this fails to correct the problem, please contact Capintec.

IMPORTANT SAFETY INFORMATION

The CRC®-15R measurement system has been carefully designed to give you years of safe and reliable performance. As with all electrical equipment, however, there are basic precautions you must observe to avoid injuring yourself, the patient or damaging the equipment.

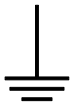
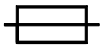
- ***Follow*** the unpacking and assembly instructions document, and ***read*** this manual carefully before using this equipment. Be sure to save all provided documents for future reference.
- ***Understand all*** warning and caution labels as explained in the **“SAFETY”** chapter before operating this equipment.

CHAPTER 1

SAFETY

These warnings and instructions for use form an integral part of the CRC®-15R and must therefore be kept available for consultation at all times. Precise compliance with the instructions is an essential condition for normal use, correct application and thus safety of the user.

SYMBOL DEFINITIONS

	Protective Earth Ground
	Functional Earth Ground
	Attention: consult owner's manual for further information
	Fuse
	AC Voltage
	"ON" (power)
	"OFF" (power)

WARNING AND CAUTION LABELS

Located on the back of the Readout Unit is a label, (see Fig. 1-1), providing the system power requirements and the replacement fuse values for power line voltages.

Please refer to CHAPTER 10: CLEANING AND MAINTENANCE for instructions on how to change the fuses of the CRC®-15R.

A fire hazard may exist if the wrong size of fuse is installed.

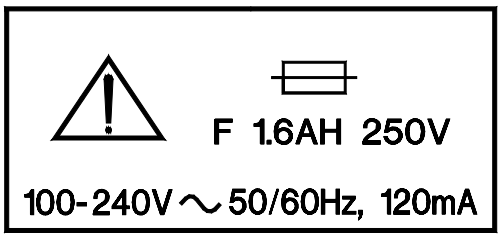


Figure 1-1

Located on the bottom of the chamber is 2 labels.

The first label, (see Figure 1-2), contains statements denoting not to remove the cover because there are no adjustments that the user can perform in the chamber.

Figure 1-2

The second label (Figure 1-3) pertains to the electrical safety of the chamber. It is necessary because of the high voltage present (approximately 180 volts) on the PC board installed in the chamber. A screwdriver is necessary to remove the cover.

Figure 1-3

CAUTIONS AND NOTES

CAUTION

Only qualified/trained personnel should operate or service this unit.

CAUTION

High voltage is present inside the chamber (up to 180 Volts). Due to the presence of this high voltage, opening the covers with the system plugged in may be hazardous. Refer all servicing to qualified personnel.

CAUTION

No internal adjustments inside the chamber may be performed by the user within the conditions of the warranty, except for changing the fuse. Due to the presence of high voltages, opening the cover with the system plugged in may be hazardous. Refer all servicing to qualified personnel.

CAUTION

Never use the calibrator without the well liner in place. Liners are inexpensive and easy to replace. A contaminated chamber is a very costly mistake. If unit becomes contaminated remove liner and clean unit as stated in CHAPTER 10: CLEANING AND MAINTENANCE before operating.

CAUTION

Care must be exercised when moving the instrument or when maintenance is performed. The shielded cylinder is heavy (13.6 kg or 30 lb.). In order to provide the required sensitivity, the wall of the ionization chamber is extremely thin and the chamber is filled with pressurized gas. It is therefore, essential to avoid mechanical shock or vibration of any kind.

CAUTION

When working with a heavy sample (especially a CapMac or Moly Assay Canister) always lower it gently into the chamber well. Dropping any heavy object into the well can cause permanent, expensive damage.

CAUTION

The use of multiplication and division factors in Calibration Numbers is only to maintain a degree of consistency with other Capintec dose calibrators. The CRC®-15R is a direct reading instrument. If multiplication or division is required, the arithmetic will be done by the system. The actual activity is displayed. DO NOT apply these factors to the displayed activity yourself.

CAUTION

It is desirable to leave the unit powered at all times in order to prevent moisture absorption and to maintain the stability of the instrument (especially if the instrument is subjected to high humidity or low temperature).

CAUTION

The sensitivity of the chamber is somewhat dependent upon the vertical position of the sample within the well. All calibrations were done with a Standard Sample placed in the supplied sample holder (dipper). It should be noted that in this configuration, the sample is not quite at the bottom of the well. If, for any reason, you make a measurement without using the dipper, be sure that the sample is in the correct vertical position. Both the CapMac and the Standard Moly Assay Canister maintain the same position as the dipper.

CAUTION

This equipment generates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful Electromagnetic Interference (EMI) to nearby devices. However, there is no guarantee that interference will not occur in a particular installation.

CAUTION

If any printer other than one of the three models supplied by Capintec is used, the safety of the unit may be compromised or Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-15R or the CRC®-15R may become susceptible to EMI.

CAUTION

The unit contains lead. Appropriate caution should be taken if the interior of the unit is exposed. The unit should be disposed of in accordance with local and national regulations.

CAUTION

The unit contains a Lithium Battery. This should be disposed of in accordance with local and national regulations.

CAUTION

The user should always verify the validity of any measurement or test result in order to minimize measurement errors.

NOTE

It is recommended that periodic (every five years) re-calibration of the unit be performed by Capintec to guarantee that the instrument's high reliability is maintained.

GENERAL SAFETY TIPS

- Unplug the equipment before cleaning it. Use only a damp cloth; do not use liquids or aerosol cleaners.
- To protect the equipment from overheating, do not use the equipment directly in front of a radiator or heat register.
- Do not use the equipment near water, or spill liquids of any kind into the equipment.
- Be sure that your power source matches the rating listed on the CRC®-15R calibrator.
- The CRC®-15R power cord has a grounded, 3-prong plug as a safety feature, and it will only fit into a grounded outlet. Do not use an adapter to defeat the grounding.
- To avoid damaging the power cord, do not place anything on it or place it where it will be stepped on. If the cord becomes damaged, replace it immediately.
- Aside from the routine maintenance described in this manual, do not try to service this equipment yourself. Do not make any adjustments other than those outlined in this manual, as you may in-validate the calibration or cause damage requiring extensive repair work. Refer servicing to qualified service personnel.

CHAPTER 2

FUNCTIONAL & TECHNICAL DESCRIPTION

FUNCTIONAL DESCRIPTION

The CRC®-15R provides a precise, accurate, fast and very convenient method of measuring the activity of a radioisotope sample for Nuclear Medicine and Brachytherapy.

The activity of the sample will be displayed with a proper unit when a sample of unknown strength (activity) of a known radioisotope is placed in the ionization chamber and the correct calibration number is selected.

The sample must be placed in the same geometry as the reference source used to determine the calibration number by using the appropriate source holder.

Note: *For a detailed description of the basic principles of the calibrator, see to APPENDIX I: PRINCIPLE OF THE CALIBRATOR.*

Activity measurements are performed by the state of the art electronic circuits in conjunction with an ionization chamber possessing extremely high sensitivity and stability.

The effects of the sample container, sample volume, and activity concentration are minimized by optimizing the counting geometries.

Nine preset nuclide keys are provided for the most often used radioisotopes.

Four user assignable nuclide keys are provided for commonly used radioisotopes that do not have a preset nuclide key.

Assays may be made reliably in the Chamber, from as low as 1 microcurie (0.1 megabequerel) for most radioisotopes to as high as 8 curies [200 giga (10^9) Becquerel] of Tc99m.

The 6cm diameter and 25cm deep ionization chamber well allows convenient measurements of virtually any radioisotope geometry in clinical use including whole generators, syringes and seed trains.

The external shield of the ionization chamber protects users from exposure to intensive radiation and reduces the effect from background radiation on low-level measurements.

Program Organization

Overall Program Flow

When the power is turned on, the Sign-On Screen appears. When the **ENTER** key is pressed, the Measurement Screen is displayed and the CRC®-15R begins measuring the activity in the Chamber.

Utility Programs

Utility Programs can be accessed by pressing **UTIL** key from the Measurement Screen. Figure 2-1 illustrates utilities available from the *Utility Menu*.

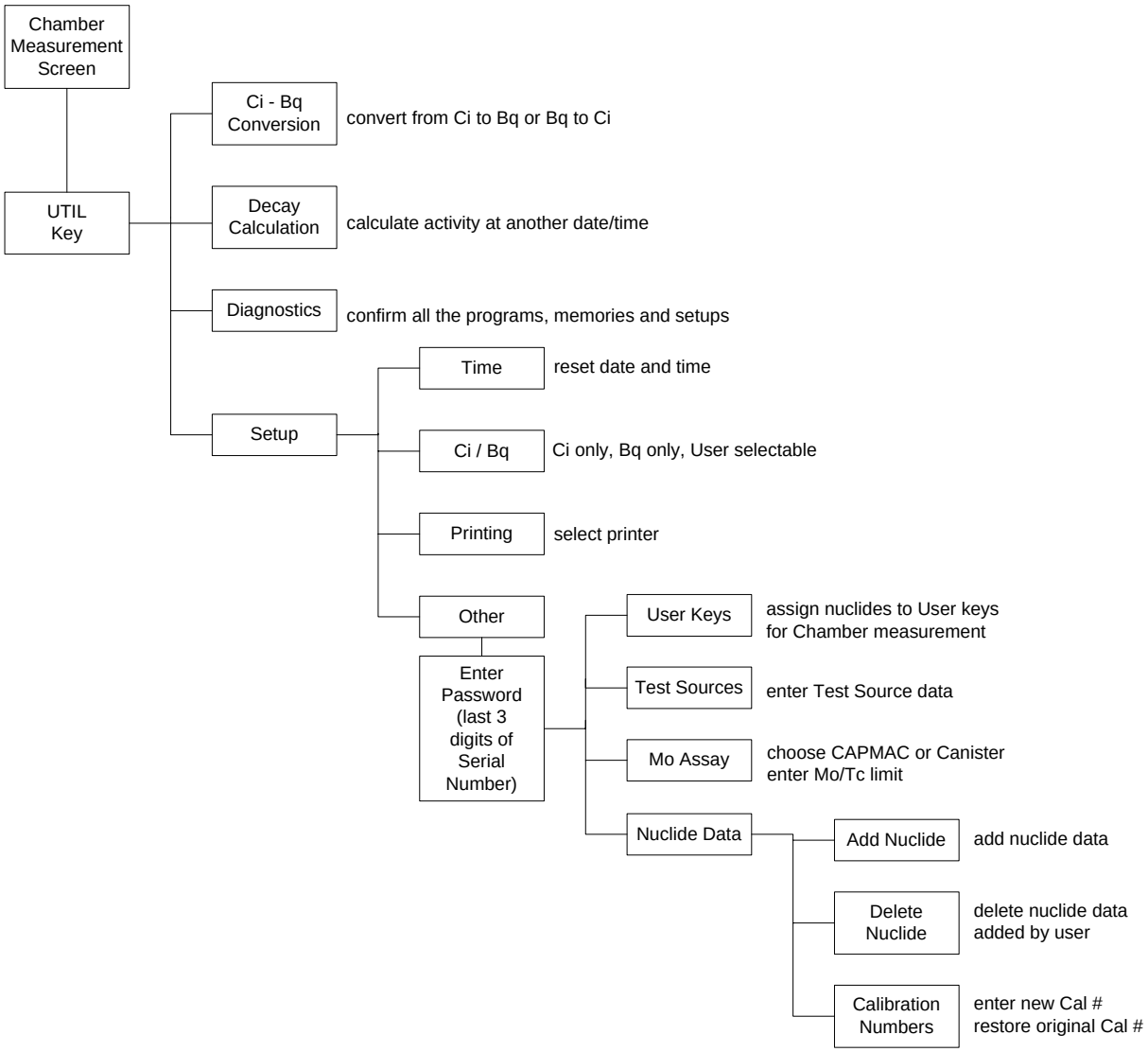


Figure 2-1 Program Flow

TECHNICAL DESCRIPTION

On / Off Switch

The on/off switch (I = on; ○ = off) is located on the back of the instrument.

Warm Up Period

Approximately 30 minutes should be allowed for the instrument to stabilize. While the instrument is warming up, it is strongly recommended that you become familiar with the CRC®-15R.

Environment Requirements

Operational

The instrument should be located where the level of the background radiation is as low and as constant as possible.

The instrument should be located where the temperature is stable within a range of +50°F to +85°F (+10°C to +30°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability and accuracy.

The instrument should be located where the barometric pressure is within a range of 27 – 31 inches of mercury (91 – 105 kilopascals).

Storage

The instrument should be stored where the temperature is stable and the range is from +39°F to +110°F (+4°C to +43°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability.

The instrument should be stored where the barometric pressure is within a range of 15 – 33 inches of mercury (51 – 112 kilopascals).

CAUTION

If these environmental requirements are not followed, the instrument may display erroneous readings.

Power Requirements

CAUTION

If the input voltage to the following items is not within the stated limits, the unit may not function correctly or may be damaged.

Line Voltage

Readout

100-240VAC, 120mA, 50/60Hz

Printers

Okidata Microline 320

120VAC, 60Hz, 0.9A or
230/240VAC, 50/60Hz, 0.5A

Epson TM-295II Slip Printer (optional)

Input: 100-240VAC, 50/60Hz, 1.2A; ***Output***: +24VDC, 0.8A

Epson TM-U200D Roll Printer (optional)

Input: 120VAC, 60Hz, 0.45A; ***Output:*** 33VDC, 1.2A or
Input: 220VAC, 50/60Hz, 1.2A; ***Output:*** +24VDC, 0.8A

Remote Display Unit

Input: 90~264VAC, 47-63Hz, 0.40A; ***Output***: +5.0 VDC, 2.4A

Line Filter

Line filter is provided internally.
Use of a filtered line is recommended if excessive line noise is anticipated.

Ground Current

less than 0.5mA

Power Connector and Cable

A grounded 3-prong plug cord for the instrument which is approved for use at the user's site must be used.
Interconnection of devices must be made using the cables supplied with the instrument.

Dimensions

Console:	Height	12.1cm	(4.75in)
	Width	25.4cm	(10.0in)
	Depth	26.7cm	(10.5in)
	Weight	1.8kg	(3.9lb)

Well Chamber:	Height	41.9cm	(16.5in)
	Diameter	17.2cm	(6.76in)
	Weight	13.6kg	(30lb)
	Well Dia.	6.1cm	(2.4in)
	Well Depth	25.4cm	(10.0in)
	Cable Length[1]	2.4m	(8ft)
Cables:	Power	1.8m	(6ft)
	Printer[2]	1.8m	(6ft)

Performance

Measurement Range:		
Maximum Activity (Tc99m in CAPMAC)	300 GBq	(8 Ci)
Maximum Activity (Tc99m)	240 GBq	(6.5 Ci)
Resolution	.001 MBq	(.01 µCi)
Electrometer Accuracy[3]	better than ±2%	
System Precision	better than ± 0.1% of FSD	
System Linearity	within ±2%	
Response Time (Low activity sample)	within 4 or 16 sec.	
Response Time (All other samples)	within ±1%	

Regulatory Listings

The CRC®-15R has been independently tested and is manufactured in compliance with the following Standards:

EMC

- European Union Norm EN 60601-1-2: Medical Electrical Equipment – Part 1 General Requirements for Safety – Section 1.2 Collateral Standard: Electromagnetic Compatibility – Requirements and Tests

Electrical

- European Union Norm EN 60601-1: Medical Electrical Equipment – Part 1 General Requirements for Safety
- European Union Norm EN 60601-1-1: Medical Electrical Equipment – Part 1 General Requirements for Safety – Section 1.1 Collateral Standard: Safety Requirements for Medical Electrical Systems

ETL Listed

[1] Longer cables are available. Consult factory.
[2] Optional
[3] Overall accuracy is determined by the calibration for the specific nuclide and the sample configuration and the accuracies of the standard sources used for calibration of the electrometer.

CHAPTER 3

GENERAL OPERATING INSTRUCTIONS

GENERAL

This section describes general operating procedures: the keyboard, how to enter data and make menu selections.

KEYBOARD

Layout

CRC®-15R keyboard is shown below.

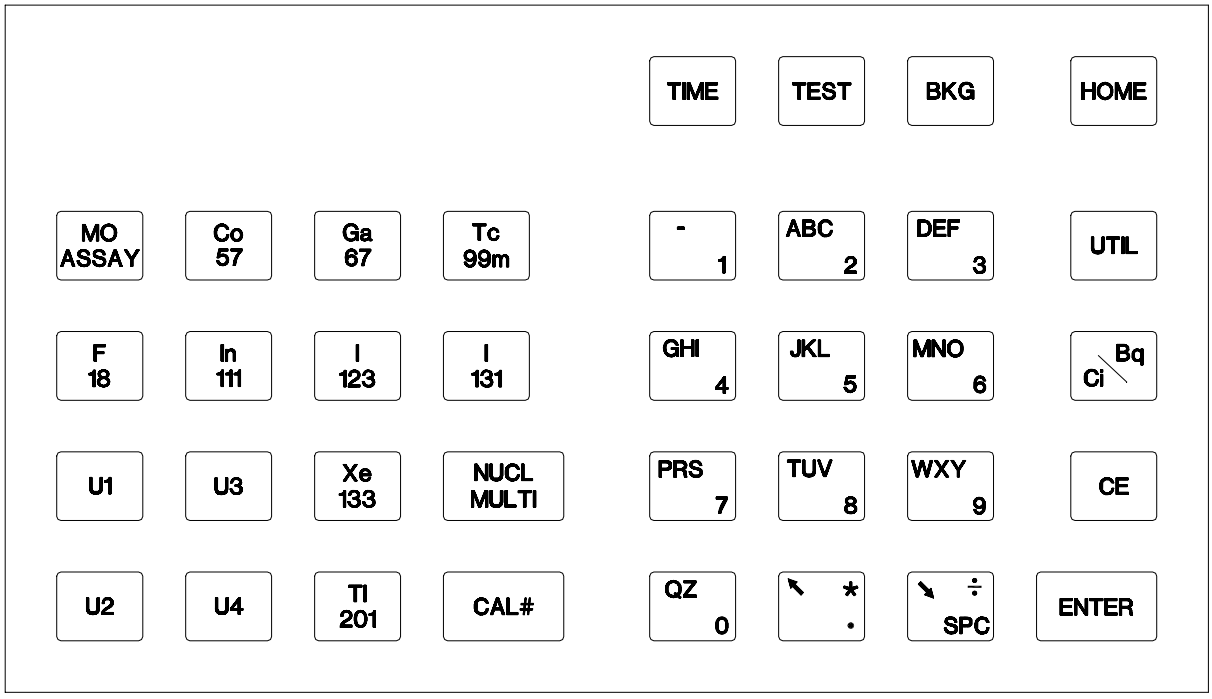


Figure 3-1 Keyboard

Key Usage

General usage of keys is briefly described. Specific key usage will be given in the appropriate sections.

NUCLIDE Keys: Co57, Ga67, Tc99m, F18, In111, I 123, I 131, Xe133, Tl201

Pressing one of these keys selects that nuclide.

USER Keys: U1, U2, U3, U4

Any nuclide in memory may be assigned to each User Key. When a key is assigned, it acts just like a Nuclide Key.

NUCL Key

Pressing this key allows the user to select any nuclide in memory (including nuclides added by the user). The nuclide is chosen using the number/letter keys.

CAL # Key

Pressing this key allows the user to input a calibration number to be used for the current measurement.

TIME Key

After pressing this key, a time and date is input. The activity at the input time of the source being measured is displayed under the current activity along with the input time and date.

TEST Key

Pressing this key brings up the Test Menu.

BKG Key

Pressing this key steps the user through the Background Measurement.

HOME Key

Pressing this key will return the user to the Measurement Screen.

If this key is pressed before ending the task being performed, the task will be terminated without being finished (e.g. entered data will not be stored and previous values are maintained).

UTIL Key

Pressing this key brings up the Utility Menu.

MO ASSAY Key

Pressing this key steps the user through a Molyassay Procedure.

NUMBER/LETTER Keys

The keys with Numbers and Letters on them are used to enter data. The decimal point is the **UP ARROW** (↖) key.

CE Key

This is the Clear Entry key and is used to erase the last character when entering data.

ENTER Key

This is used to accept entered data and print a record of the measurement.

ARROW Keys (↖ and ↘)

When alpha numeric input is being entered, the Arrow keys are used to scroll through the possible values on each number/letter key.

During a Chamber measurement, the arrows are used to change the precision of the displayed measurement for low activity.

When a multi-field entry is being made (e.g. date, time, activity, half-life) the arrows are used to move to the next field or to change the value of the unit.

Ci / Bq Key

Pressing this key toggles the measurement between Curies and Becquerels.
It is only active if USER SELECTABLE has been chosen for Ci/Bq.

Entering Data

Numeric Data

Numeric data is entered via the NUMBER/LETTER keys on the right hand side of the keyboard.

The decimal point is on the same key as the **UP ARROW** (↖).

If the entry must be an integer, the decimal point will not be allowed.

Press **CE** to erase the last digit entered.

Press **ENTER** when a correct entry has been made.

Alphanumeric Data

Alphanumeric data (numbers and letters) are also entered via the NUMBER/LETTER keys.

When a NUMBER/LETTER key is pressed, the number appears. Use the **ARROW** keys to change the number into one of the letters on the same key. When the **UP ARROW** (↖) is pressed, the letters appear in the clockwise direction. When the **DOWN ARROW** (↘) is pressed, the letters appear in the counter clockwise direction.

Making Menu Selections

All menus appear with a number in front of each selection.

To make a selection, press the NUMBER/LETTER key corresponding to the desired selection.

Responding to Questions (Yes or No)

There are several occasions where the user is asked a question which is to be answered Yes or No.

Press **Y** (9, WXY) for Yes. Press **N** (6, MNO) for No.

CHAPTER 4

SYSTEM SETUP

GENERAL

Initial installation and checkout procedures are described in this section.

RECEIVING CONDITION EXAMINATION

Be sure to verify that the shipping carton is received in good condition, i.e., no damage should be visible and the box should be dry and clean.

Should the instrument be received in a damaged condition, save the shipping container and the packing material and request an immediate inspection by the carrier.

Capintec, Inc. is not responsible for the damage, which occurs during shipment but will make every effort to help obtain restitution from the carrier.

UNPACKING AND INSTALLATION

The instrument is packed and shipped as a complete unit. All the accessories are contained in the carton. (If an optional printer or remote display is included, they will be in separate cartons)

The instrument is shipped in a plastic bag in order to provide a dry and clean environment during shipment.

CAUTION

Be sure the instrument has reached room temperature prior to opening the bag. (Leave the box in the room 4 hours before opening it.)

1. Remove all outer packing material and tapes. The shipping and packing material should be saved for future use.

2. The following equipment should be found upon unpacking:

   - Readout Unit
   - Chamber and Liner/Dipper
   - Power Cord
   - Remote Display and cable (if ordered)
   - Printer (if ordered)
     - OKIDATA MICROLINE 320, or
     - EPSON SLIP PRINTER, or
     - EPSON ROLL PRINTER

The Printer should have the following accessories:

- Power Supply
- Printer Ribbon
- Communications Cable
- Roll Paper (If Roll printer ordered)
- Tickets (If Ticket printer ordered)

Note: *If Test Sources are ordered, they will be shipped separately.*

3. Be sure to remove all tape and protective material from the instrument prior to connecting to the power line.

ASSEMBLY

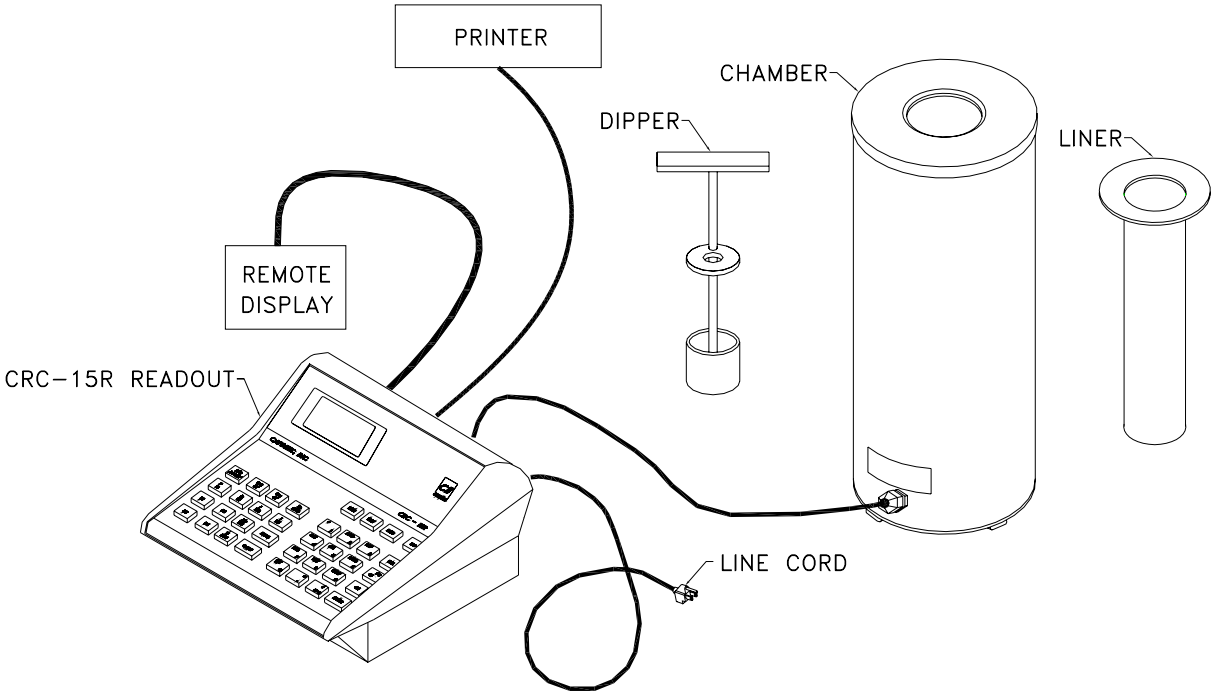


Figure 4-1

1. Verify that all power switches (Readout, Printer, Remote Display) are in the “OFF” or “0” position. (***Note:*** *If using the Slip-Ticket printer, please unplug from AC Power*)

2. Connect the Chamber Cable to the connector at the rear of the CRC®-15R Readout labeled “CHAMBER”.

3. Attach the Power Cable to the receptacle on the Power Module located on the back of the Readout Unit.

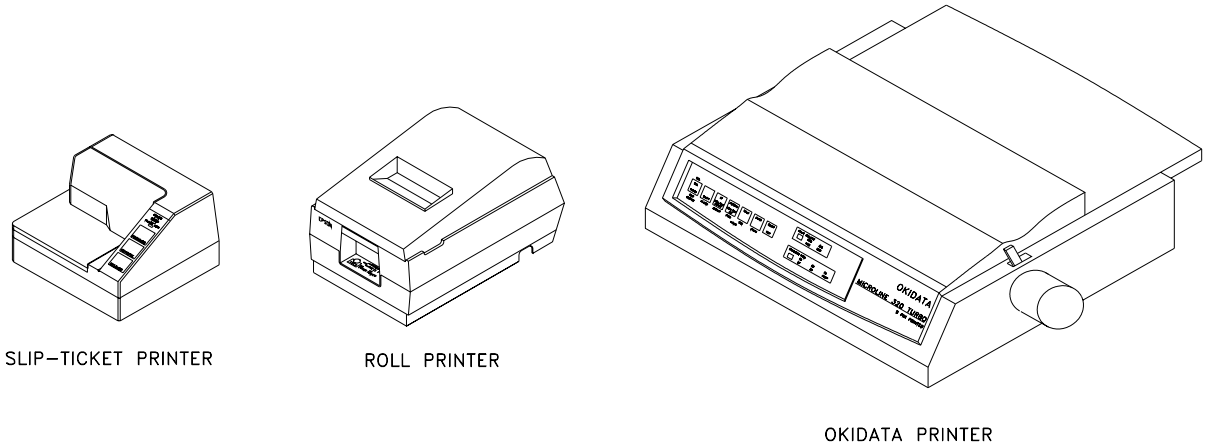


Figure 4-2 Printers

4. Attach the printer cable (one end has a 9 pin “D” connector, the other end has a 25 pin “D” connector) to the connector at the rear of the CRC®-15R Readout marked “PRINTER”. Attach the other end to the printer.

   Note: *Do not attach the printer cable to the “RS-232” connector.*

5. For each printer type, verify that the correct paper is installed. (***Note:*** *the Slip-Ticket printer paper is manually inserted at the time of printing.*)

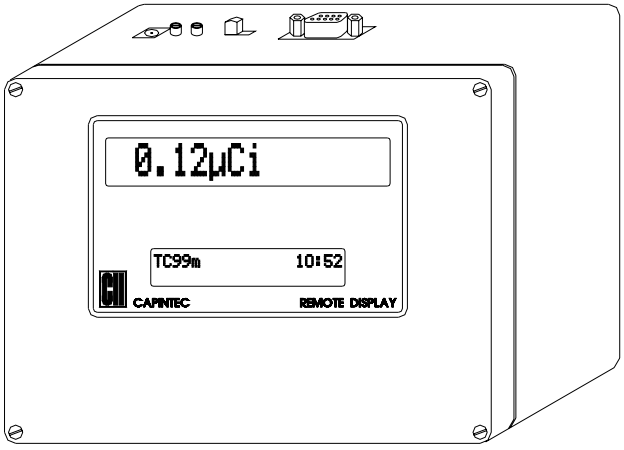


Figure 4-3 Remote Display

6. Connect the Remote Display Cable (both ends have a 9 pin “D” connector) to the connector at the rear of the CRC®-15R labeled “RS-232”. Attach the other end to the Remote Display labeled “DATA”.

Note: *Do not attach the Remote Display cable to the "PRINTER" connector.*

7. Attach the Remote Display Power Supply to the Remote Display power input jack labeled as "DC IN".

ENVIRONMENT REQUIREMENTS

The instrument should be located where the level of the background radiation is as low and as constant as possible.

The instrument should be located where the temperature is stable within a range of 50°F to 85°F (10°C to 30°C) and the maximum relative humidity is 90% non-condensing to warrant maximum reliability and accuracy.

The instrument should be located where the barometric pressure is within a range of 27 – 31 inches of mercury (91 – 105 kilopascals).

CAUTION
If these environmental requirements are not followed, the instrument may display erroneous readings.

POWER REQUIREMENTS

CAUTION
If the input voltage to the following items is not within the stated limits, the unit may not function correctly or may be damaged.

Readout

100-240VAC, 120mA, 50/60Hz

Printers

Okidata Microline 320
120VAC, 60Hz, 0.9A or
230/240VAC, 50/60Hz, 0.5A

Epson TM-295II Slip Printer (optional)
Input: 100-240VAC, 50/60Hz, 1.2A; ***Output***: +24VDC, 0.8A

Epson TM-U200D Roll Printer (optional)
Input: 120VAC, 60Hz, 0.45A; ***Output***: 33VDC, 1.2A or
Input: 220VAC, 50/60Hz, 1.2A; ***Output***: +24VDC, 0.8A

Remote Display Unit

Input: 90-264VAC, 47-63Hz, 0.40A; ***Output***: +5.0 VDC, 2.4A

TURN ON PROCEDURES

1. Be sure the interconnecting cable from the detector assembly is properly plugged into the back of the main unit.
2. Confirm the power requirements of the instrument.
3. Be sure the power switch is off. (Push lower part of the toggle switch next to the power receptor located on the rear of the main unit.)
4. Plug the power plug into a grounded three-wire outlet of the specified power line.
5. Turn on the Display Unit using the power switch located at the rear of the unit.
6. The unit should now display the CRC®-15R start up screen (see Figure 4-4)

CAUTION

Accidental connection of the power plug into a DC line or to an AC line which exceeds the specified voltage may result in catastrophic damage to the instrument's circuits.

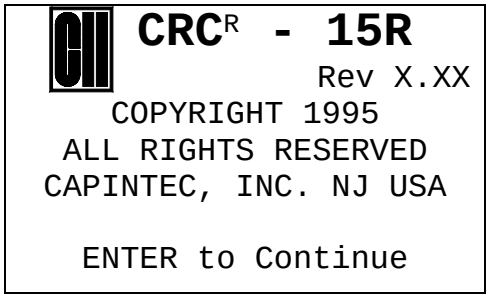


Figure 4-4

Note: *The screen will display the revision level of the installed software.*

GENERAL OPERATIONAL SETUP

There are several things that **must** be done before using the CRC®-15R Radioisotope Dose Calibrator for the first time. The following briefly describes these steps:

- Verify or set the date/time: Although the date and time are set in the factory, you should verify that the date and time are correct for your location. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING DATE AND TIME.
- Select proper units: Ci or Bq. Although the system can be changed at any time, it is recommended that the user set the proper units prior to using the unit to prevent confusion. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: CHOOSING Ci or Bq.

- Enter Test Source Data: Test sources (standard sources) are used for the accuracy and constancy tests. The accuracy may be tested using Co57, Co60, Ba133, Cs137 or Ra226. There can be a Test Source for each of these nuclides. One or more of the Test Sources must be designated as the source(s) to be used in the Daily Test. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING TEST SOURCE DATA.
- Enter Constancy Test Source: The source for the Constancy Test is chosen from the sources designated as Daily Sources. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: CONSTANCY TEST SOURCE.
- Verify correct printer setting: The CRC®-15R may be used with three printers: See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: PRINTING.
    - OKIDATA MICROLINE 320
    - EPSON SLIP PRINTER
    - EPSON ROLL PRINTER

The following items should be performed before use if required:

- Assign USER Keys: The USER Keys (U1, U2, U3, U4) are a quick way to select a nuclide. A nuclide may be assigned to each key. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: USER KEY ASSIGNMENT.
- Adding a Nuclide: The CRC®-15R contains nuclide data (name, half-life, calibration number) for over 80 nuclides. The user may add up to 10 nuclides. The name and half-life and calibration number will be added for each one. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ADDING A NUCLIDE.
- Changing Calibration Numbers: The user is allowed to change the calibration number of up to 10 built-in nuclides. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: CHANGING CALIBRATION NUMBERS.
- Selecting Moly Assay Method: Moly Assay can be performed using the CAPMAC or CANISTER. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: SELECTING MOLY ASSAY METHOD.
- Setting MO/MT Limit: The Mo/Tc limit is set at the factory to 0.15µCi/mCi. The user can change this value. See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: VIEWING OR CHANGING Mo/Tc LIMIT.

ACCEPTANCE TESTING

The following tests should be performed prior to operational use of the unit.

Diagnostics Test

See CHAPTER 7: TESTS, SECTION: DIAGNOSTIC TEST for instructions on how to perform this test.

Daily Test

See CHAPTER 7: TESTS, SECTION: DAILY TEST for instructions on how to perform this test.

Accuracy Test

See CHAPTER 7: TESTS, SECTION: DAILY TEST for instructions on how to perform this test.

OPERATIONAL SUMMARY

While all users the CRC®-15R are strongly encouraged to read the manual, we realize that there are some who would much rather jump right in. If you are one of those people who say "if all else fails, read the manual", then refer to Appendix IV. These very simplified instructions are intended to assist in getting you familiar with the basic operation of the CRC®-15R. They are not intended to replace the detailed operating directions in the main body of the manual.

WARNING

The General Operational Setup and Acceptance Testing sections above must be performed before referring to Appendix IV. The steps described omit several important tests which may be required by your license and which are also required in order to achieve the full accuracy of the system. Samples measured without the complete start-up procedure having been performed should not be administered to patients.

CHAPTER 5

SYSTEM INITIALIZATION

GENERAL

This section describes initialization and parameter setup.

All of these functions are accessed via the *Main Utility Menu*.

Press **UTIL** from the Measurement Screen.

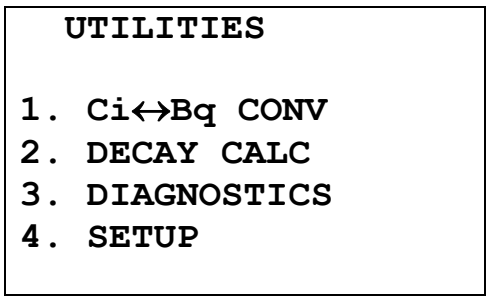


Figure 5-1 Utility Menu

ENTERING DATE AND TIME

To view and/or change the date and/or time, press **UTIL** from the Measurement Screen and then press **4** to select *SETUP*.

The *Setup Menu* screen should be displayed (Figure 5-2).

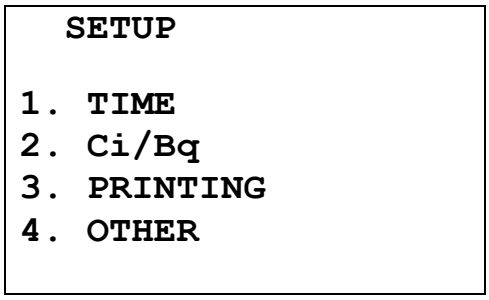


Figure 5-2 Setup Menu

Press **1** to view and change the date and/or time.

The current date and time will be displayed:

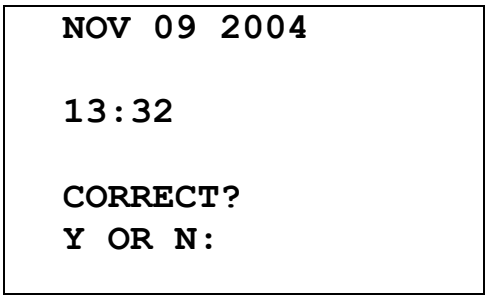


Figure 5-3 Date and Time Verification

If the date or time is not correct, press **N**.

The date/time entry screen will appear with the current date and time displayed in the order hour, minute, day, month, year:

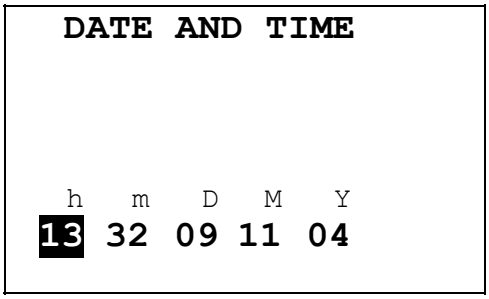


Figure 5-4 Date / Time Entry Screen

Note that time in input in 24 hour format (e.g., 5:29am is 05 29, 5:29pm is 17 29).

Use the arrow keys to highlight the field that you want to change (you can back up by using the left arrow) and then enter the new value.

The date and time are checked for validity. If an invalid date or time is entered, a beep sounds and the current date and time are displayed again.

Press **ENTER** when the correct date and time have been entered.

The Date and Time Verification Screen will appear with the date and time just entered.

CHOOSING Ci or Bq

Measurement results can be displayed in Ci or Bq. The **Ci/Bq** key is used to switch the measurement result between Ci and Bq. However, in some facilities, it may be decided to disable this feature and allow measurements to be displayed only in Ci or only in Bq. When the system arrives, it is set up to display in Ci and Bq.

To enable or disable Ci/Bq switching:
Press **UTIL** from the Measurement Screen.
Press **4** to select *SETUP*.

From the *Setup Menu*, press **2** to select Ci/Bq. The current Ci/Bq selection will be shown. The example below is for the default of Selectable (i.e., the user may select Ci or Bq)

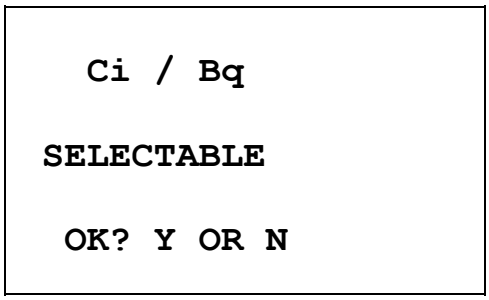


Figure 5-5 Ci/Bq Verification Screen

If it is correct, press **Y**.

If it is not correct, press **N**. The *Ci/Bq Selection Menu* will appear:

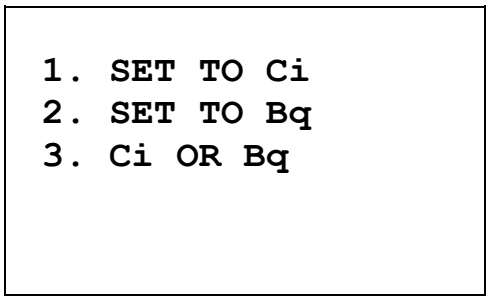


Figure 5-6 Ci/Bq Selection Screen

Press **1**, **2** or **3** to make the correct selection.

The Ci/Bq Verification Screen will re-appear with the new selection.
If **1** was pressed, the selection will be: FIXED TO Ci.
If **2** was pressed, the selection will be: FIXED TO Bq.
If **3** was pressed, the selection will be: Ci / Bq SELECTABLE.

INPUTTING TEST SOURCE DATA

Test Sources (Standard Sources) are used for the Accuracy and Constancy Tests.

The Accuracy and Constancy may be tested using Co57, Co60, Ba133, Cs137 or Ra226. There can be a Test Source for each of these nuclides. One or more of the Test Sources must be designated as the source(s) to be used in the Daily Test. One of the daily sources must be designated as the source to be used for the Constancy Test.

The *Test Source Menu* allows you to enter data for any Test Source and to choose a Constancy Source.

When the Measurement Screen appears, press **UTIL**.
From the *Utility Menu* (Figure 5-1), press **4** to select *SETUP*.
From the *Setup Menu* (Figure 5-2), press **4** to select *OTHER*.

When the Password Entry Screen appears, input your password (last 3 digits of your serial number) and press **ENTER**. The *Other Menu* screen will then appear (Figure 5-7).

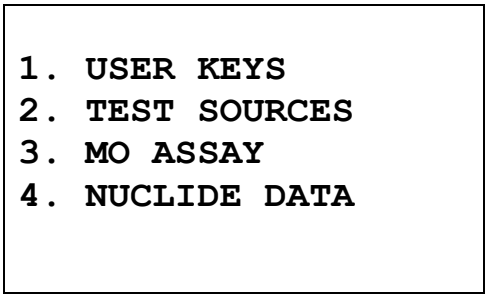


Figure 5-7 Other Menu

Press **2** to select *TEST SOURCES*. The *Test Source Menu* will appear:

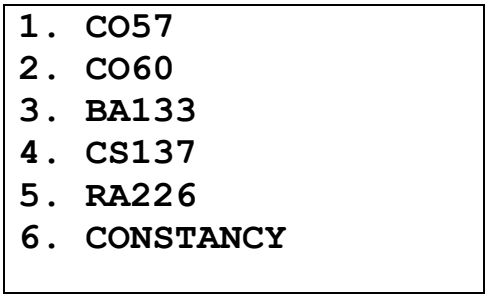


Figure 5-8 Test Source Menu

Press **1**, **2**, **3**, **4** or **5** to enter, change or delete the Test Source for the designated nuclide.

Source Verification

The previously entered data will be displayed. If there is no data for that nuclide, the message “NO SOURCE” will be displayed. The example below is for Co57 which will be used in the Daily Test.

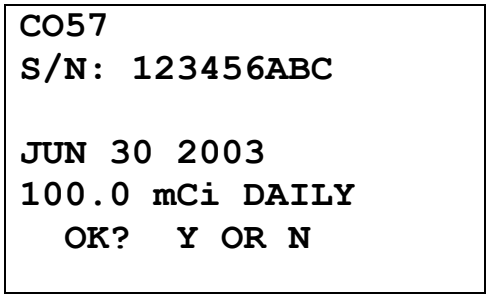


Figure 5-9 Test Source Verification

If the data is correct press **Y**.

To change the data, press **N**. To add a source (if “NO SOURCE”) or delete a source which is no longer being used, press **N**.

If **N** was pressed and there was data displayed, you will have the opportunity to delete the source:

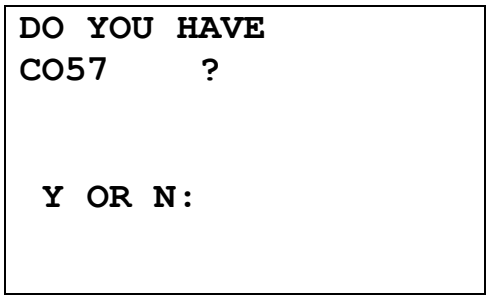


Figure 5-10 Source Existence

If you are no longer using the source, press **N** and it will be deleted.

Press **Y** to enter data for the source.

Entering Serial Number

The serial number may be any combination of 10 numbers and letters.

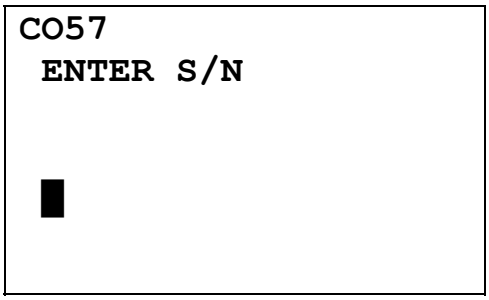


Figure 5-11 Entering Serial Number

Follow the directions in CHAPTER 3: GENERAL OPERATING INSTRUCTIONS, SECTION: ALPHANUMERIC DATA for entering alphanumeric data.

Press **ENTER** when a correct serial number has been entered.

Entering Calibration Date

The calibration date is input next:

The Date Entry Screen will appear with the current date displayed in the order: day month year. The day is highlighted.

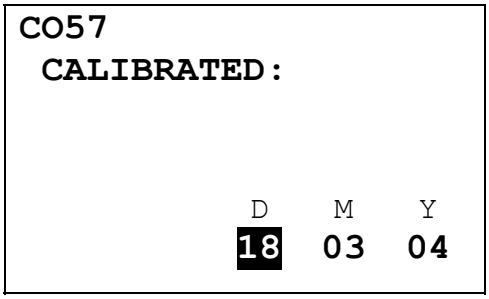


Figure 5-12 Date Entry Screen

The entry format is similar to entering date and time (See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING DATE AND TIME) except that only the date is entered.

Input the Source calibration date and press **ENTER**.

The date is checked for validity. If an invalid date is entered a beep sounds and the current date is displayed again.

Entering Calibration Activity

The calibration activity can now be entered:

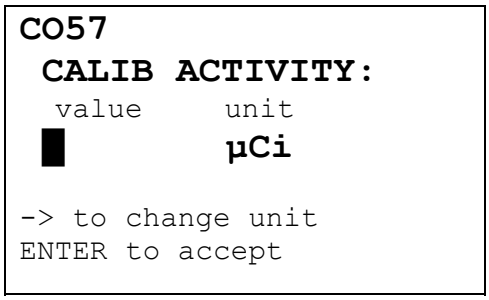


Figure 5-13 Entering Activity Screen

Input the value of the calibrated activity and then press the **RIGHT ARROW (↘)**. Use the arrow keys to scroll the activity units: µCi, MBq or mCi. If the value needs to be changed, press the **CE** key.

When the value and unit are correct, press **ENTER**.

Note: *The Calibration activity must be less than 1 Ci. The current activity (calibration activity decayed to the present time) must be greater than the activity in the table below.*

	Minimum at Current Time
Co57	50. µCi
Co60	50. µCi
Ba133	50. µCi
Cs137	50. µCi
Ra226	10. µCi

Indicating Daily Usage

You must now indicate whether the source will be used for the Daily Test:

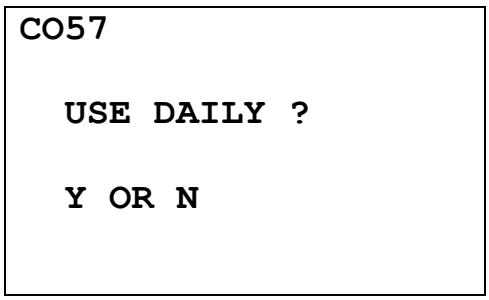


Figure 5-14 Daily Use Screen

If the source is to be used in the Daily Test, press **Y**. If it will not be used in the Daily Test, press **N**.

Confirming Calibration Data

The Test Source Verification Screen (Figure 5-9) will now be displayed with the data you have just entered. If the data is correct, press **Y**. If there is any error, press **N**.

If **N** is pressed, you will be returned to the Source Existence Screen (Figure 5-10).

CONSTANCY TEST SOURCE

The source for the Constancy Test is chosen from the sources designated as Daily Sources. (If there are no Daily Sources, the error message "NO DAILY SOURCE WAS CHOSEN – ANY KEY TO CONTINUE" will appear.)

To select the source to use in the Constancy Test:

Press **UTIL** from the Measurement Screen.
From the *Utility Menu*, press **4** to select *SETUP*.
From the *Setup Menu*, press **4** to select *OTHER*.
When the password entry screen appears, input your password (last 3 digits of your serial number) and press **ENTER**.
Press **2** to select *TEST SOURCES*.
Press **6** to select *CONSTANCY*.

The source for the Constancy Test is chosen from the sources designated as Daily Sources.

If only one Test Source is designated as a Daily Source, it will be set as the Constancy Test Source as shown.

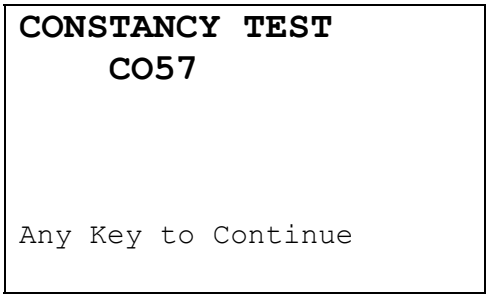


Figure 5-15 Constancy Source Verification

If more than one Test Source is designated as a Daily Source and one of the sources was already set as the Constancy Test Source, you will be asked if it is OK. In the example below, Co57 is the current source.

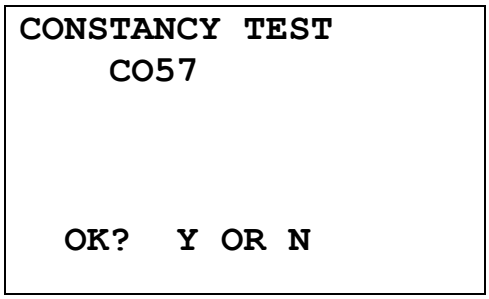


Figure 5-16 Constancy Source Verification Screen

If you answer No, you will be asked to select the Constancy Test Source from the Test Sources that were designated as Daily Sources (Figure 5-17).

If more than one Test Source is designated as a Daily Source and none of the sources were set as the Constancy Test Source, you will be asked to select one of the Test Sources that were designated as Daily Sources. In the example below, Co57 and Co60 were designated as Daily Sources:

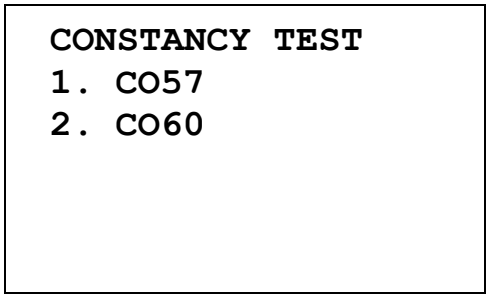


Figure 5-17 Constancy Test Source Selection

Enter the number corresponding to the source to be used for the Constancy Test. The Constancy Source Verification screen (Figure 5-16) will reappear showing the selected source.

USER KEY ASSIGNMENT

The **USER Keys** (U1, U2, U3, U4) are a quick way to select a nuclide. A nuclide may be assigned to each key.

Press **UTIL** from Measurement Screen.
Press **4** to select *SETUP*.
Press **4** to select *OTHER*.
Input your password (last 3 digits of serial number).
From the *Other Menu* (Figure 5-7), press **1** to select *USER KEYS*.

Selecting User Key

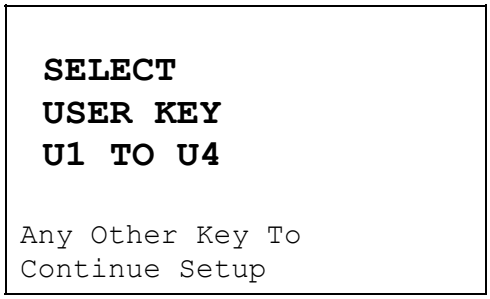


Figure 5-18 User Key Selection Screen

Press the User Key to which a nuclide is to be assigned.

Press any other key to exit User Key Assignment.

Current Assignment Display

The current key assignment will be displayed. In the example, Co60 has been assigned to U1.

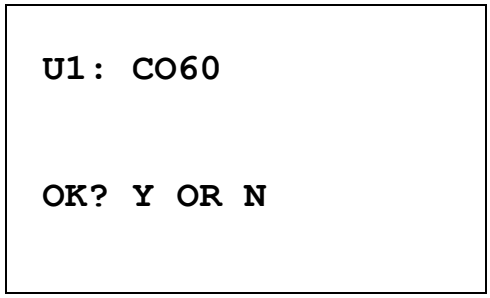


Figure 5-19 User Key Verification Screen

If no assignment has been made, the word NONE will appear after the key name.

If the assignment is correct, press **Y** and you will be returned to User Key Selection Screen.

Press **N** to change the assignment.

Nuclide Name Assignment

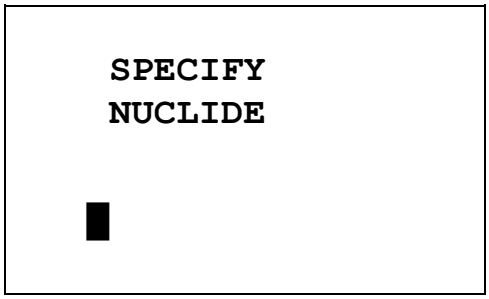


Figure 5-20 Nuclide Name Assignment Screen

Press the alphanumeric keys corresponding to the nuclide name. The number on each key will appear. For example, if Cs137 is entered, 27137 will appear. Press **ENTER** when the nuclide has been specified.

To change the assignment to NONE, press **ENTER** without specifying a nuclide.

Assignment Confirmation

The User Key Verification Screen will appear with the nuclide just entered.

If it is correct, press **Y**.

If it is not correct, press **N** and Nuclide Name Assignment Screen will re-appear.

ADDING A NUCLIDE

The CRC®-15R contains nuclide data (name, half-life, calibration number) for over 80 nuclides.

The user may add up to 10 nuclides. The name and half-life and calibration number will be added for each one.

Press **UTIL** from the Measurement Screen.
Press **4** to select *SETUP*.
Press **4** to select *OTHER*.
Input your password (last 3 digits of the serial number) and press **ENTER**.
From the *Other Menu* (Figure 5-7), press **4** to select *NUCLIDE DATA*.

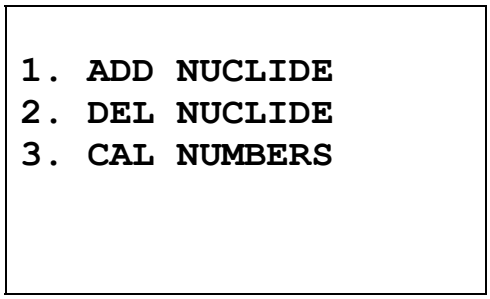


Figure 5-21 Nuclides Menu

Press **1** to select *ADD NUCLIDE*.

Entering Nuclide Name

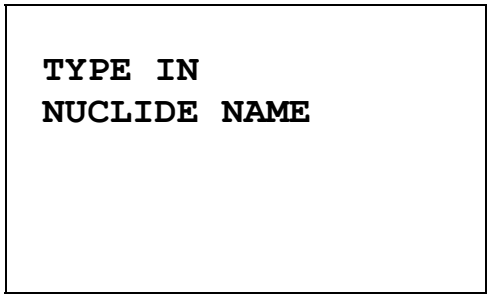


Figure 5-22 Entering Nuclide Name Screen

User the NUMBER/LETTER keys to input the nuclide name. The first 2 characters will be displayed as letters (use the **1** key for a blank if there is only 1 character in the name) and the next 3 characters as numbers. If the nuclide is in a metastable state, use the **Tc99m** key on the left of the keyboard for the m.

Press **ENTER** when the nuclide name has been entered.

Entering Half-Life

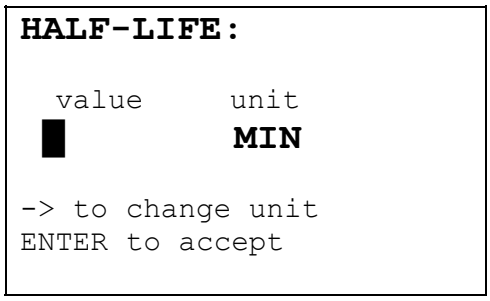


Figure 5-23 Entering Half-Life Screen

Enter the value of the half-life and then press the **RIGHT ARROW** (↘). Use the arrow keys to scroll the half-life from Min to Year to Day to Hour. If the value needs to be changed, press the **CE** key.

When the value and unit are correct, press **ENTER**.

Entering Calibration Number

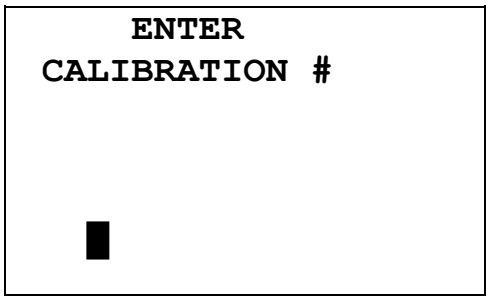


Figure 5-24 Enter Calibration Number Screen

Input the calibration number if known. If the calibration number is not known then it can be determined by the following procedure.

Determining Calibration Numbers

An initial Calibration Number (as an initial starting point choose 450) must be entered into the CRC®-15R for the nuclide.

Note: *In order to obtain a correct reading for a Vial or Syringe, the supplied liner and dipper must be used to achieve the correct geometry. If the source is contained in a different type of container, then contact Capintec, Inc. for further assistance.*

1. Place the standard source of the nuclide in the chamber and record the displayed activity.
2. If the displayed activity is **higher** than the measured/calculated activity of the standard source, ***increase*** the Calibration Number. If the displayed activity is **lower** than the measured/calculated activity of the standard source, ***decrease*** the Calibration Number.
3. Re-measure the activity of the standard source.
4. Continue to increase or decrease the Calibration Number (e.g. repeat steps 2 and 3) until the displayed activity matches the measured/calculated activity of the standard source.
5. Record the Calibration Number of the nuclide for future reference.
6. Enter the calibration number.

DELETING A NUCLIDE

Any nuclide added by the user may be deleted.

When the *Nuclide Menu* appears, press **2** for *DEL NUCLIDE*.

When "SPECIFY NUCLIDE" appears, specify the nuclide to be deleted via the Number/Letter keys.

The name of the nuclide and its half-life will be displayed. If this is the correct nuclide to delete, press **Y**; if not, press **N**.

CHANGING CALIBRATION NUMBERS

The user is allowed to change the calibration number of up to 10 built-in nuclides.

To change a calibration number or restore the original number:

Press **UTIL** from the Measurement Screen.
Press **4** to select *SETUP*.
Press **4** to select *OTHER*.
Enter your password (last 3 digits of the serial number) and press **ENTER**.
From the *Other Menu*, press **4** to select *NUCLIDE DATA*.

When the *Nuclide Menu* appears, press **3**, *CAL NUMBERS*.

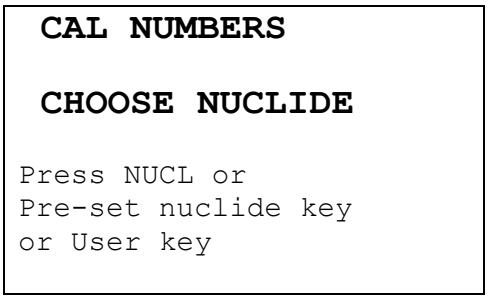


Figure 5-25 Choose Nuclide for User Defined Calibration Number Screen

Choose the nuclide via **NUCL** key, pre-set nuclide key or user key.

Entering User Defined Calibration Number

If the nuclide does not have a new calibration number, the following screen appears (example is for Tc99m):

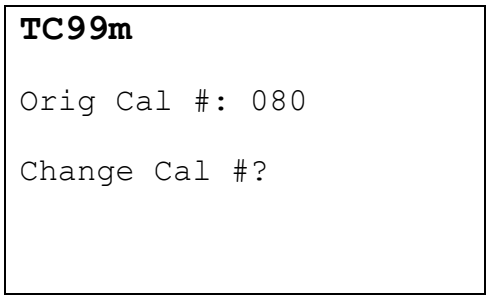


Figure 5-26 Change Original Cal#? Screen

If you want to change the calibration number, press **Y**; if not press **N**.

If **Y** is pressed, you will enter the new calibration number.

After the calibration number is entered, the original and new calibration numbers will be displayed for verification.

Restoring Original Calibration Number

If a user defined calibration number has been entered for the chosen nuclide, the following screen appears (in the example, 082 is the new cal# for Tc99m)

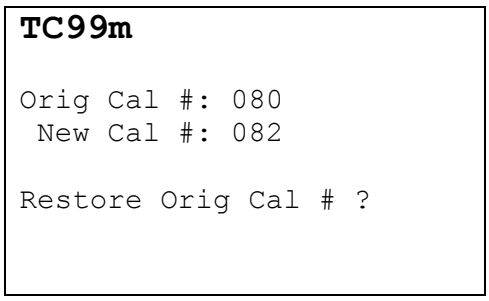


Figure 5-27 Restore Original Cal#? Screen

Press **Y** to restore the original calibration number. Press **N** to keep the new calibration number.

SELECTING MOLY ASSAY METHOD

Moly Assay can be performed using the CAPMAC or CANISTER. When Moly Assay is chosen, the Moly Assay Method Selection Screen will appear. However, if you always use either CAPMAC or CANISTER, the Moly Assay Method Selection screen can be skipped by making the choice in utilities.

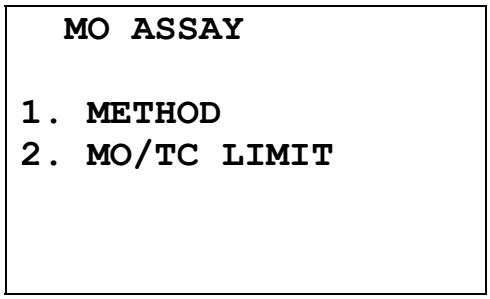


Figure 5-28 Mo Assay Menu

Press **1** to select *METHOD*.

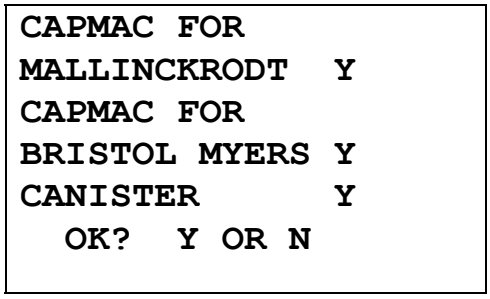


Figure 5-29 Moly Assay Method Verification Screen

Press **N** the change the selection.

You will then be asked if you will use “CAPMAC FOR MALLINCKRODT GENERATOR”. Press **Y** or **N**.

You will next be asked if you will use “CAPMAC FOR BRISTOL MYERS GENERATOR”. Press **Y** or **N**.

You will next be asked if you will use “CANISTER”. Press **Y** or **N**.

The Moly Assay Method Verification Screen will reappear.
Press **Y** if the selection is correct. Press **N** to change the selection.

VIEWING AND CHANGING MO/TC LIMIT

The Mo/Tc limit is set at the factory to 0.150µCi/mCi. This value can be changed by the user.

From the *Moly Assay Menu*, press **2** to select *MO/TC LIMIT*.

The current value will be displayed:

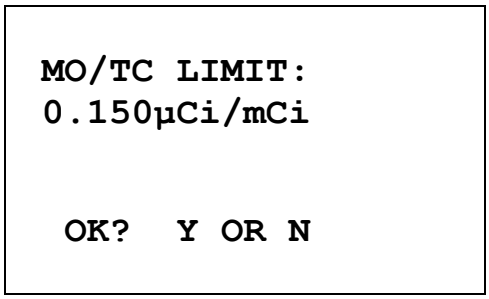


Figure 5-30 Mo/Tc Limit Verification Screen

Press **Y** to keep the value.

Press **N** to change the value.

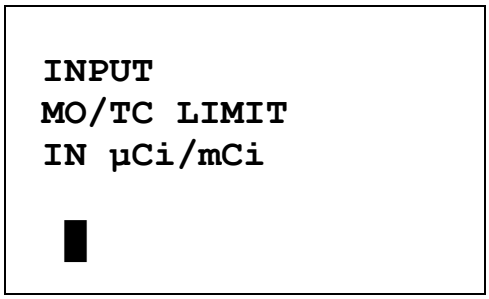


Figure 5-31 Mo/Tc Limit Entry Screen

Input the new value and press **ENTER**. You will be returned to the Mo/Tc Limit Verification Screen.

Note: *If Bq had been chosen before entering Utilities, the Mo/Tc limit would be displayed and entered in MBq/GBq.*

PRINTING

CAUTION

If any printer other than one of the three models supplied by Capintec is used, Electromagnetic Interference (EMI) may be introduced into other devices located in the same general area as the CRC®-15R.

The CRC®-15R may be used with three printers:

- OKIDATA MICROLINE 320
- EPSON TM-295II SLIP PRINTER
- EPSON TM-U200D ROLL PRINTER

Printer Power Requirements

Okidata Microline 320
120VAC, 60Hz or
230/240VAC, 50/60Hz

Epson TM-295II Slip Printer (optional)
Input: 100-240VAC, 50/60Hz, 1.2A; ***Output***: +24VDC, 0.8A

Epson TM-U200D Roll Printer (optional)
Input: 120VAC, 60Hz, 0.45A; ***Output***: 33VDC, 1.2A or
Input: 220VAC, 50/60Hz, 1.2A; ***Output***: +24VDC, 0.8A

Printer Selection

If the OKIDATA 320 is used, the calibration measurement can be printed on a ticket or as a single line.

To view and/or change the selected printer (and the type of measurement printout if OKIDATA is used):

Press **UTIL** from the Measurement Screen and then press **4** to select *SETUP*.

When the *Setup Menu* (Figure 5-2) appears, press **3** to select *PRINTING*.

The currently selected printer will be displayed. If OKIDATA is selected, “TICKET” or “ONE LINE” will be displayed. You will be asked if the display is correct. If the display is not correct, press **N** (no).

The Printer Selection Screen will appear:

```
PRINTER IS

1. SLIP-TICKET
2. ROLL
3. OKI
4. NONE
```

Figure 5-32 Printer Selection Menu

Press the number corresponding to your printer, or press **4** for *NONE* if you do not have a printer.

If OKI is selected, you must now choose to print the measurement as a *TICKET* or a *SINGLE LINE*:

```
PRINT
MEASUREMENT ON

1. TICKET
2. ONE LINE
```

Figure 5-33 Printout Selection Menu

Select the type of measurement printout.

After selecting the printer (and measurement printout) your selection will be displayed for verification.

Okidata Menu Setup

As it comes from the factory, the Okidata printer should be set-up to function properly with the CRC®-15R. Should you experience printer difficulties, such as not printing, improper print spacing, printing the wrong characters, etc., make sure that the printer Setup is exactly as indicated in Figure 5-34. If any differences are found, they must be corrected.

The buttons referred to are all located on the front panel of the printer. The Paper Lever is on the right side of the top surface of the printer near the paper roller.

To print and correct the Setup:

1 Make sure that the form paper is properly loaded in the printer.

2 Press the **SEL** button (to take printer off-line).

3 Press **SHIFT + MENU (SEL)** to enter the Setup Menu.

4 Press the **PRINT** button and the entire Setup listing will print.

5 If there are no differences between what just printed and Figure 5-34 go to step 10.

6 Press the **GROUP** button. The first line of the first group of lines of the Setup will print.

7 If all lines in the group just printed match the corresponding lines in Figure 5-34, repeat step 6 for the next group.

8 If any line in the group just printed does not match the corresponding line in Figure 5-34, it must be corrected. For example, to change the Baud Rate to 4800:

   A. Press the **GROUP** button until Serial I/F is printed.

   B. Press the **ITEM** button until Baud Rate is printed.

   C. Press the **SET** button until 4800 BPS is printed.

9 If any differences remain, return to step 6 for the next group.

10 Press the **SHIFT + MENU (SEL)** buttons to return to **SEL** (on-line).

Note: *The Setup printout shown in Figure 5-34 is for example only. Your printer Setup may differ slightly from that shown. Verify that the settings, which are the same between your Setup and that shown, concur.*

Figure 5-34 Listing of the *Turbo* OKIDATA 320 Printer Set-Up Data

Printer Control	Emulation Mode	IBM PPR
Font	Print Mode	Utility
Font	DRAFT Mode	HSD
Font	Pitch	10 CPI
Font	Proportional Spacing	No
Font	Style	Normal
Font	Size	Single
Symbol Sets	Character Set	Set I
Symbol Sets	Language Set	American
Symbol Sets	Zero Character	Slashed
Symbol Sets	Code Page	USA
Rear Feed	Line Spacing	8 LPI
Rear Feed	Form Tear-Off	Off
Read Feed	Skip Over Perforation	No
Rear Feed	Page Length	11”
Bottom Feed	Line Spacing	8 LPI
Bottom Feed	Form Tear-Off	Off
Bottom Feed	Skip Over Perforation	No
Bottom Feed	Page Length	11”
Top Feed	Line Spacing	8 LPI
Top Feed	Bottom Margin	Valid
Top Feed	Page Length	11”
Top Feed	Wait Time	1 sec
Top Feed	Page Length Control	by Actual Page Length
Set-Up	Graphics	Uni-directional
Set-Up	Receive Buffer Size	16K
Set-Up	Paper Out Override	No
Set-Up	Print Registration	0
|||\

CHAPTER 6

ACCEPTANCE & QUALITY ASSURANCE TESTS

GENERAL

To insure proper operation of the CRC®-15R, the following tests should be preformed at the indicated intervals.

ACCEPTANCE TESTS

The following tests must be preformed in the following order before the initial use of the CRC®-15R:

- Diagnostic Test
- Daily Test
- Accuracy (for those nuclides that are not used in the Daily Test)

Diagnostic Test

When *DIAGNOSTICS* is selected, the system diagnostic testing will begin. The instrument's memories and the programs are checked (this takes about 1 to 2 minutes) and the results printed and displayed. If any of these tests (RAM, PROM or EEPROM) fail, contact Capintec's Authorized Service Center. See CHAPTER 7: TESTS, SECTION: DIAGNOSTIC TEST for detailed instructions.

Daily Test

The Daily Tests should be conducted at the beginning of each working day, prior to measuring any samples, which will be administered to patients. These tests consist of an Auto Zero operation, a Background Adjustment, a System Test, a Data Check, an Accuracy Test, and a Constancy Test. Consider using one or more sources of different photon energy and activity for these tests. See CHAPTER 7: TESTS, SECTION: DAILY TEST for detailed instructions.

When **TEST** is pressed from the Measurement Screen, the *Test Menu* appears:

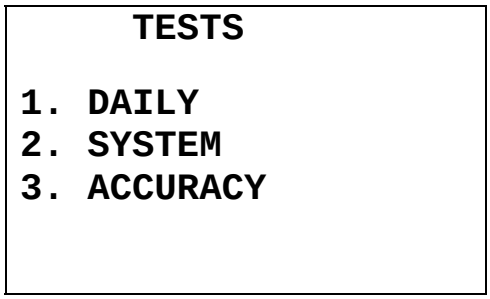


Figure 6-1 Test Menu

Press the **1** key to begin the Daily Test.

When the test is complete, if a printer is connected to the system, a report is printed. An example of the Daily Test Report is illustrated in Figure 6-2. If no printer is available, you may record the data by hand. Copies of the completed reports (either printed or hand written) should be retained in a safe place.

Accuracy Test

If your Accuracy Test setup (CHAPTER 7: TESTS, SECTION: ACCURACY and CONSTANCY TEST) includes nuclides that are not used in the Daily Tests, you should perform the Accuracy Test with those nuclides. It will not be necessary to repeat the test for those nuclides which were included in the Daily Test.

CRC-15R RADIOISOTOPE DOSE CALIBRATOR **Nov. 11,2004 13:26**

S/N Main Unit: 123456 Rev: 4.00 Capintec, Inc. USA
Chamber: 456789
Printer: 258741

DAILY TESTS:

ZERO: -0.05 mV
BACKGROUND: .35µCi
SYSTEM TEST: 160.2 volts
DATA CHECK: ALL OK

ACCURACY TEST:

Source:	Co57	Cs137
Serial #:	EPOXY-VIAL	ABCDEFGHIJ
Stand. Source(S):	2.36 mCi	111.4 µCi
Measured As (M):	2.36 mCi	112.3 µCi
Deviation(M-S)/S:	-0.1%	0.9%

Daily test report.

CONSTANCY TEST:

Standard Source: Co57 S/N: EPOXY-VIAL

Nuclide	Activity
CO57	2.36 mCi
GA67	2.51 mCi
TC99m	2.81 mCi
C 11	860. µCi
IN111	1.200 mCi
I 123	1.29 mCi
I 131	1.97 mCi
N 13	.86 mCi
CR51	25.1 mCi
XE133	1.70 mCi
TA179	2.27 mCi
CO60	.43 mCi
TL201	1.60 mCi
MOCAP	16.12 mCi
TCCAP	3.65 mCi
SR85	1.67 mCi
HG203	2.61 mCi
F 18	.89 mCi
IN113m	2.88 mCi
AU199	3.36 mCi

_____

signature By : 77

Figure 6-2 Daily Test Report

QUALITY ASSURANCE TESTS

Daily Tests

The Daily Tests should be conducted at the beginning of each working day, prior to measuring any samples, which will be administered to patients. These tests consist of an Auto Zero operation, a Background Adjustment, a System Test, a Data Check, an Accuracy Test, and a Constancy Test. See CHAPTER 7: TESTS, SECTION: DAILY TEST for detailed instructions.

Contamination Test

This test is normally performed at the end of each work day. At the very least, it should be performed once per week. To test for contamination of the dipper and/or well liner:

1. Make sure that the dipper is in the well and there is no source in the dipper.
2. Press **Co57** and then **SPC**.
3. Record the displayed activity.
4. Remove the dipper from the well and record the displayed activity.
5. Subtract the activity in step 4 from the activity in step 3. This is the amount of contamination of the dipper.
6. Remove the liner from the well and record the displayed activity.
7. Subtract the activity in step 6 from the activity in step 4. This is the amount of contamination of the liner.
8. Should either the dipper or the liner exhibit contamination greater than 3 µCi or 0.1 MBq, they should be decontaminated or replaced.
9. Return the liner to the well.

CAUTION

Never use the calibrator without the well liner being in place. Liners are inexpensive and easy to replace. A contaminated chamber is a very costly mistake.

QUARTERLY TESTS

The Quarterly Tests consist of:

- Diagnostic Test
- Daily Test
- Accuracy Test (for those nuclides that are not used in the Daily Test)
- Linearity Test

Daily and Diagnostic Tests

The normal Daily Tests should be performed as a part of the Quarterly Tests. The operation of the Daily Tests is fully described in CHAPTER 7: TESTS. At least one accuracy measurement (See CHAPTER 7: TESTS, SECTION: ACCURACY TEST) must be included in the test sequence.

The Diagnostic Test described in this chapter should be done as a part of the Quarterly Test sequence also.

Accuracy Test

If your Accuracy Test setup (See CHAPTER 7: TESTS, SECTION: ACCURACY TEST) includes nuclides that are not used in the Daily Tests, you should perform the Accuracy Test with those nuclides as a part of the Quarterly Test. It will not be necessary to repeat the test for those nuclides, which were included in the Daily Test.

This test is essentially the same as the Accuracy Test described in CHAPTER 7: TESTS, SECTION: ACCURACY TEST. There are, however, three differences. First, this test is performed independently from the other portions of the Daily Test sequence. Second, it may be set up to use nuclides other than those used in the Daily Tests. Third, as you are doing the test you can opt to skip some nuclides.

If there is a printer connected to the system, the test results will automatically be printed at the end of all source measurements.

The Accuracy Tests cannot be conducted until the Reference Source data has been entered. To start the Accuracy Tests, press **TEST**. You will then see the display illustrated in Figure 6-3.

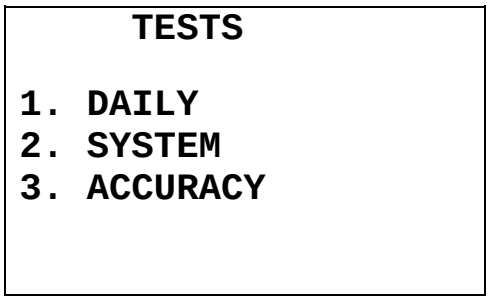


Figure 6-3

Select *ACCURACY* by pressing **3**.

The test will start with a display similar to that illustrated in Figure 6-4. The actual nuclide and serial number of the check source will, of course, depend upon how you have initially defined the test.

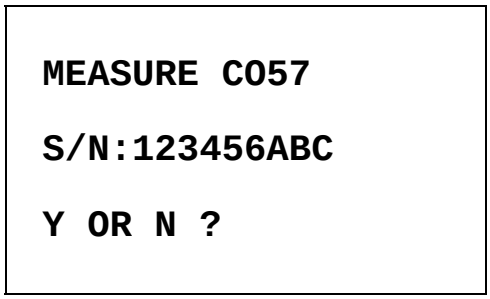


Figure 6-4

If you want to test with this source press the **Y** key. If not, press **N**.

If you answered, “Yes”, you will see a display similar to that illustrated in Figure 6-5. If not, you will continue with the next source.

Begin the test by inserting the requested check source into the well. The number in the center of the display is the measured activity. The number in the upper right corner of the display is the anticipated actual activity of the check source based upon the initial calibration of the source, corrected for decay. The number on the bottom of the display is the percent deviation of the measured activity from the anticipated activity. If the deviation is greater than ±20%, the reading will be replaced by a dashed line.

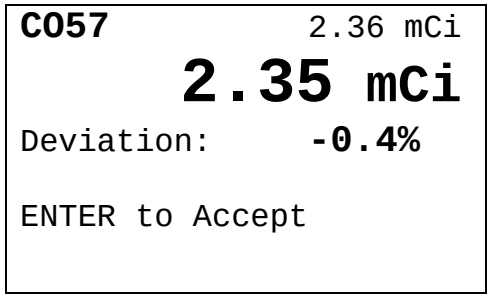


Figure 6-5

Press **ENTER** to accept the measurement.

If the Reference Source data for the Accuracy Test includes more than one nuclide, the test sequence will repeat as many times as required. At the end of the last test, if there is a printer attached, the test results will be printed and you will be asked if you wish to print again.

Press **Y** to answer Yes and the test results will be printed again.

Press **N** to answer No and you will return to the Measurement mode.

Linearity Test

The linearity of the CRC®-15R should be checked over the entire range of activities which are reasonably anticipated to be used. This can be done by any of several methods. The three most common methods are described below.

Decay Method

Start by measuring the activity of a sample of Tc99m or other nuclide of reasonably short half-life. The activity of the sample should be at least as large as the maximum assayed in normal use. At regular intervals, make repeated measurements of the same sample as it decays. Continue until the activity is below the minimum assayed in normal use.

CAUTION

Initially the activity of the Mo99 contamination in the sample will be insignificant compared to the activity of the Tc99m. However, Mo99 has a much longer half life than Tc99m. If the test is continued down to very low levels, the activity of the Mo99 may become significant by the end of the test. If this is not taken into account, it may adversely affect the results of the test.

Sleeve Method

There are several manufacturers of sets of shielding “sleeves” that may be used for performing the linearity test. When testing by this method, follow the directions that come with the set. Be sure that you calibrate the sleeves first.

Proportional Method

The linearity can be confirmed by measuring the activity of a sample and then checking the activity of carefully measured portions of the sample. The activity of the initial sample should be at least as large as the maximum assayed in normal use. The ratio of the measured activities should be the same as the ratio of the measured weights or volumes. The weights or volumes must be measured to a degree of accuracy much greater than the expected linearity (i.e. ±0.5%)

CHAPTER 7

TESTS

GENERAL

When **TEST** is pressed from the Measurement Screen, the *Test Menu* appears:

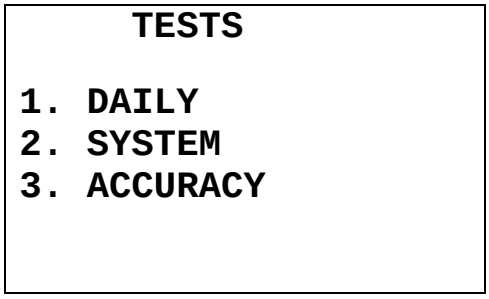


Figure 7-1 Test Menu

DAILY TEST

The Daily Test is selected by pressing the **1** key on the keypad.

The Daily Test consists of:

- Auto Zero
- Background
- System Test
- Data Check
- Accuracy Test
- Constancy Test

Auto Zero

The first part of the Daily Test is the Auto Zero.

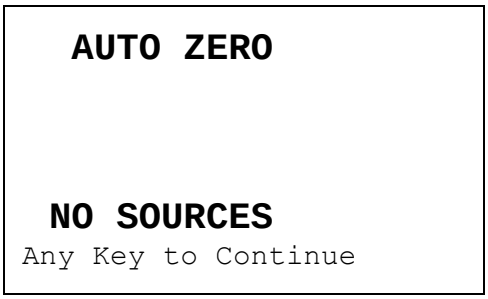


Figure 7-2 Auto Zero Instructions

Remove all sources from the vicinity of the Chamber and press any key.

You will be told to wait until a measurement is available.

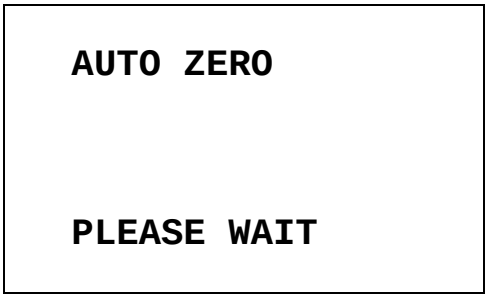


Figure 7-3 Auto Zero Please Wait Screen

The results screen will appear:

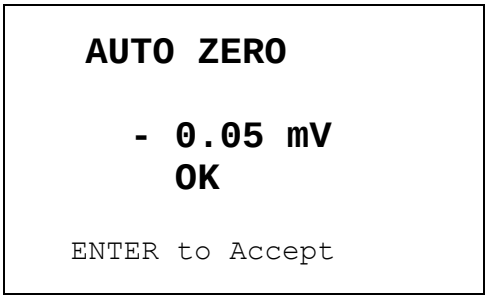


Figure 7-4 Auto Zero Results Screen

Press **ENTER** to accept the result and continue the Daily Test.

If the value has drifted since the last measurement, it will be indicated. Check to make sure no sources are in the area. If any sources are found, remove them and repeat the measurement.

If the value is out of range, an error message will appear. Check to make sure no sources are in the area. If any sources are found, remove them and repeat the measurement. If no sources were found, consult Capintec's Authorized Service Center.

Background

The second part of the Daily Test is Background measurement. Background measurement can also be performed by pressing the **BKG** key. If Background is performed via the **BKG** key, you will first be told to remove all sources:

You will be told to wait until a measurement is available.

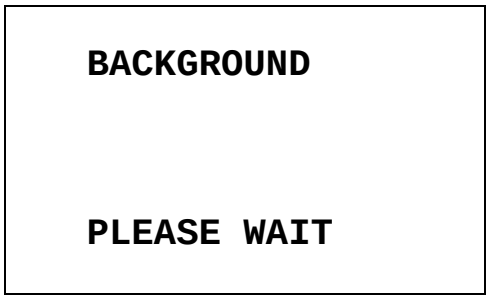


Figure 7-5 Background Please Wait Screen

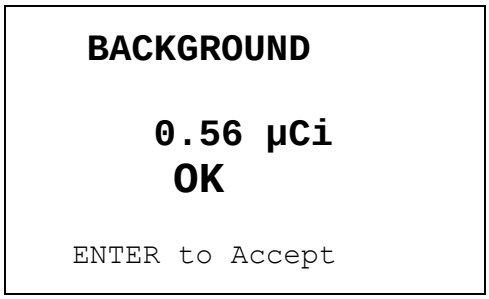


Figure 7-6 Background Results Screen

If the background is high but still acceptable (> 27µCi and < 500µCi or > 1MBq and < 20MBq) the word “HIGH” will appear instead of “OK”. Although the value is acceptable, the reason for the high value should be investigated. If any sources are found nearby, repeat the measurement.

If the background is above the acceptable range (> 500µCi or > 20MBq), the value will not be shown but the Background Too High Screen will appear:

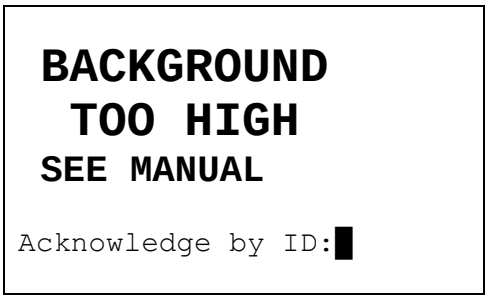


Figure 7-7 Background Too High Screen

This background cannot be accepted by the CRC®-15R. If the cause of the high reading (nearby source, contaminated well etc.) cannot be found, consult Capintec's Authorized Service Center.

System Test

The third part of the Daily Test is the System Test. The System Test can also be performed by pressing **2** on the keypad when at the *Test Menu* (Figure 7-1).

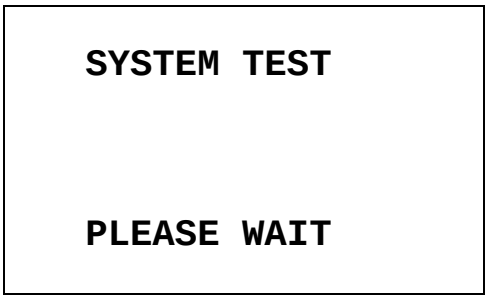


Figure 7-8 System Test Please Wait Screen

When a measurement is available, it is compared with the value entered at the factory and displayed:

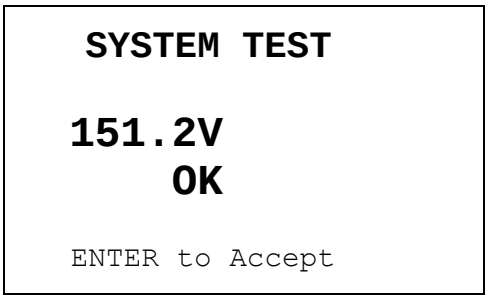


Figure 7-9 System Test Results Screen

If the results are out of range, the message "FAIL SEE MANUAL" appears. If this happens, contact Capintec's Authorized Service Center.

Data Check

The next part of the Daily Test is a check of the built-in nuclide data.

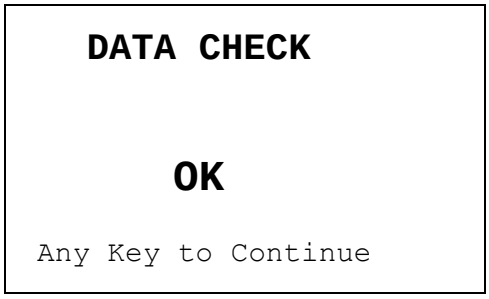


Figure 7-10 Data Check Results

If this test ever fails, consult Capintec's Authorized Service Center.

Accuracy Test and Constancy Test

Accuracy and Constancy Test in Daily Test

The next part of the Daily Test is the Accuracy Test. You will be stepped through performing the Accuracy Test for all sources, which have been designated as a Daily Source (See CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING TEST SOURCE DATA). When the source designated as the Constancy Source has been measured, you will be instructed to perform the Constancy Test.

In the example below, Co57 is the Daily Source and the Constancy Source.

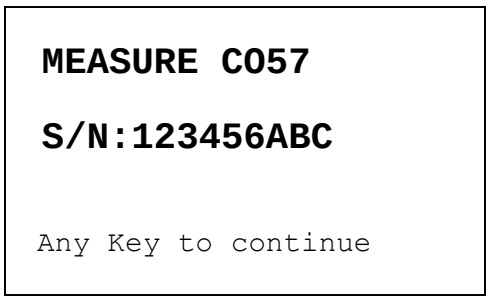


Figure 7-11 Accuracy Test in Daily Test Instruction Screen

Press any key to continue testing.

The measurement screen will appear with the calculated activity of the source in the upper right hand corner. The deviation between the measured activity and the calculated activity will be displayed. If the deviation is greater than ±20%, dashes will be shown instead of the deviation – this indicates an error condition (perhaps the wrong source is being measured).

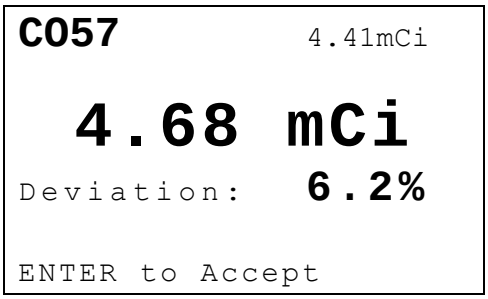


Figure 7-12 Accuracy Test Measurement Screen

Press **ENTER** to accept the measurement.

If the source being measured is not the Constancy Source, the instruction screen for the next Daily Source will appear.

If the source being measured is the Constancy Source, the Constancy Test Instruction Screen will appear:

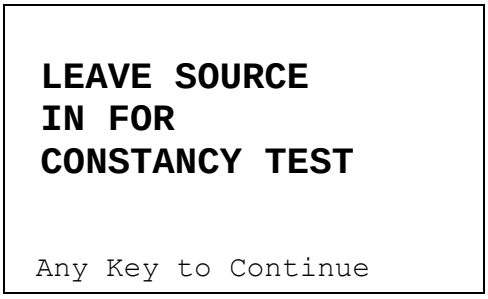


Figure 7-13 Constancy Test Instruction Screen

When any key (except **HOME**) is pressed, the Constancy Measurement Screen for the nuclide that is the Constancy Source will appear:

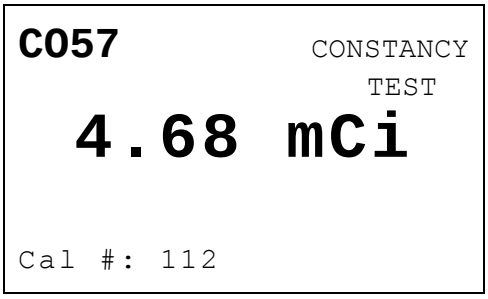


Figure 7-14 Constancy Test Measurement Screen

To perform Constancy Test for other nuclides, press any pre-set nuclide key, user key or specify nuclide via **NUCL** key.

When all Constancy Tests are done, press **ENTER** to end the test.

The Daily Test report will be printed.

Accuracy Test from Menu

Accuracy Test can also be performed by pressing **3** on the keypad when at the *Test Menu* (Figure 7-1). This will allow you to perform the test using any of the Test Sources.

The "Accuracy Test Measure?" screen will appear for each Test Source (Co57 is again used as the example):

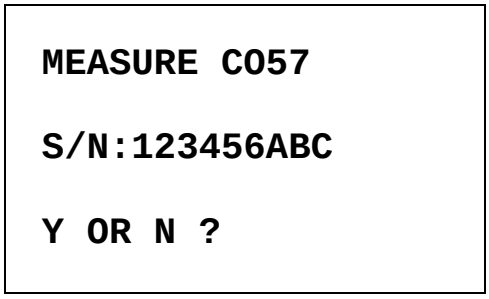


Figure 7-15 Accuracy Test Measure? Screen

Press **Y** to measure the source. Press **N** to skip the measurement and proceed to the next Test Source.

When all desired sources have been measured, the Accuracy Test Report will be printed.

DIAGNOSTIC TEST

When *DIAGNOSTICS* is selected, the system diagnostic testing will begin. The instrument's memories and the programs are checked (this takes about 1 to 2 minutes) and the results printed and displayed. If any of these tests (RAM, PROM or EEPROM) fail, contact Capintec's Authorized Service Center.

Press **UTIL** from the Measurement Screen.
Press **3** to select *DIAGNOSTICS*.

If a printer is part of the system, but is not ready for printing, you will see the display illustrated in Figure 7-16. If you want a printed report, get the printer ready before doing anything else. Press any key (except **HOME**) to continue. If the printer is ready, or if the system does not include a printer, this step will be skipped.

Nuclear data and other system values will be printed. This printout should be kept for future reference.

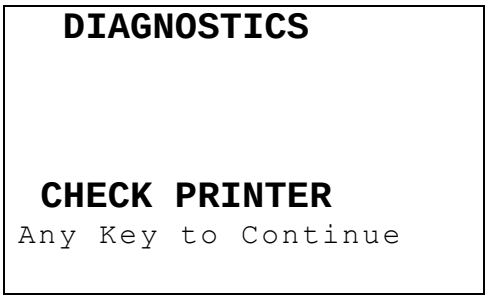


Figure 7-16

Note: *The above message "Check Printer" is displayed if the OKI Printer is selected as the system printer. If the SLIP Printer is selected as the system printer, the Message is "Connect Printer". If the ROLL Printer is selected as the system printer, no Message is displayed.*

Next, you will see the screen illustrated in Figure 7-17. The PROM test requires about 1-1/2 minutes. Be patient.

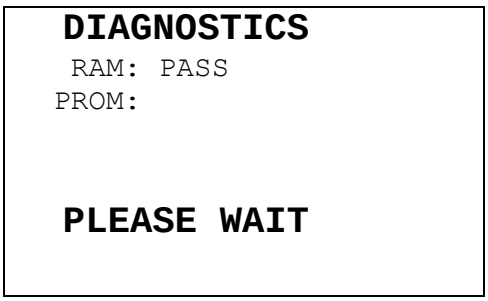


Figure 7-17

The test results will appear on the display similar to that illustrated in Figure 7-18. The test should always indicate PASS for RAM, PROM, and EEPROM. If any of these tests indicate FAIL, copy all of the other data on the display and contact Capintec's Authorized Service Center. When you have finished viewing the results, press any key to continue.

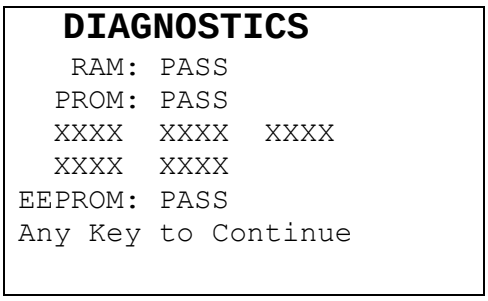


Figure 7-18

Diagnostics Printout

Examples of the printout are shown on the following pages for the Okidata 320 printer. (The PROM values are just examples).

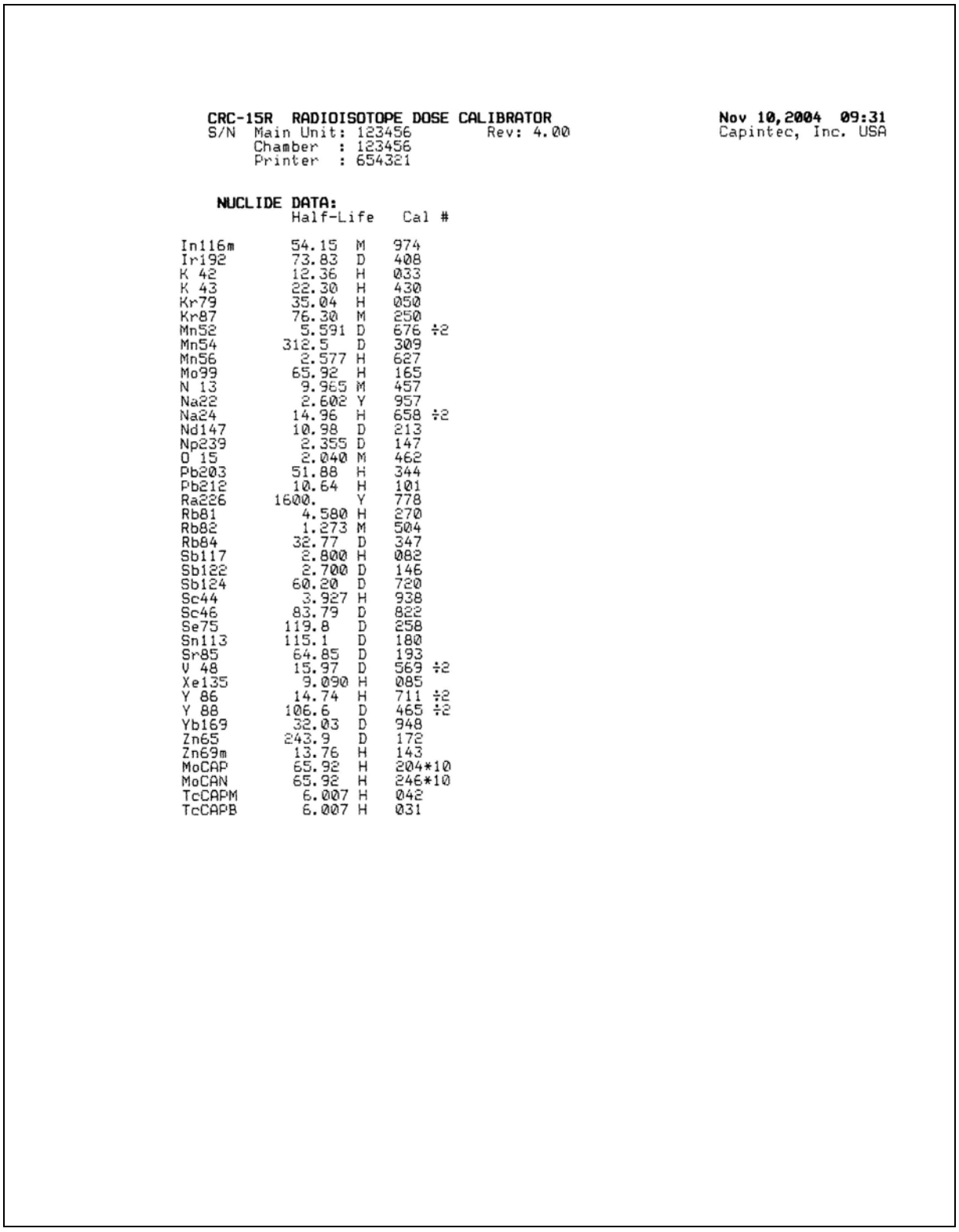
Figure 7-19 Diagnostics Printout on OKIDATA Printer (page 1 of 4 pages)

CRC-15R RADIOISOTOPE DOSE CALIBRATOR **Nov 10,2004 09:31**
S/N Main Unit: 123456 Rev: 4.00 Capintec, Inc. USA
Chamber : 123456
Printer : 654321

NUCLIDE DATA:

	Half-Life		Cal #	
Tc99m	6.007	H	060	
I 131	8.021	D	151	
I 123	13.22	H	277	
Xe133	5.243	D	188	
Ga67	3.261	D	100	
Tl201	72.91	H	205	
In111	2.805	D	303	
Co57	271.7	D	112	
F 18	109.7	M	439	
Ag110m	249.8	D	554	÷2
Am241	432.2	Y	055	
Ar41	1.827	H	468	
As72	26.00	H	795	
As74	17.78	D	304	
As76	26.32	H	110	
Au198	2.696	D	149	
Au199	3.139	D	053	
Ba131	11.80	D	505	
Ba133	10.50	Y	591	
Bi207	32.20	Y	846	
Br77	56.00	H	091	
C 11	20.38	M	457	
Ce139	137.6	D	352	
Co55	17.54	H	481	
Co58	70.82	D	389	
Co60	5.271	Y	990	
Cs131	9.690	D	148	
Cs132	6.475	D	485	
Cs134	2.065	Y	726	
Cs136	13.10	D	489	÷2
Cs137	30.00	Y	220	
Cu64	12.70	H	015	
Cu67	2.575	D	052	
Dy157	8.100	H	424	
Fe52	8.275	H	374	
Fe59	44.51	D	430	
Ga66	9.400	H	903	
Ga68	68.00	M	416	
Ga72	14.10	H	470	÷2
Hf181	42.40	D	387	
Hg197	64.10	H	197	
Hg203	46.60	D	093	
I 124	4.180	D	570	
I 125	59.60	D	319	
I 130	12.36	H	984	
In113m	1.658	H	076	

Figure 7-19 Diagnostics Printout on OKIDATA Printer (page 2 of 4 pages)

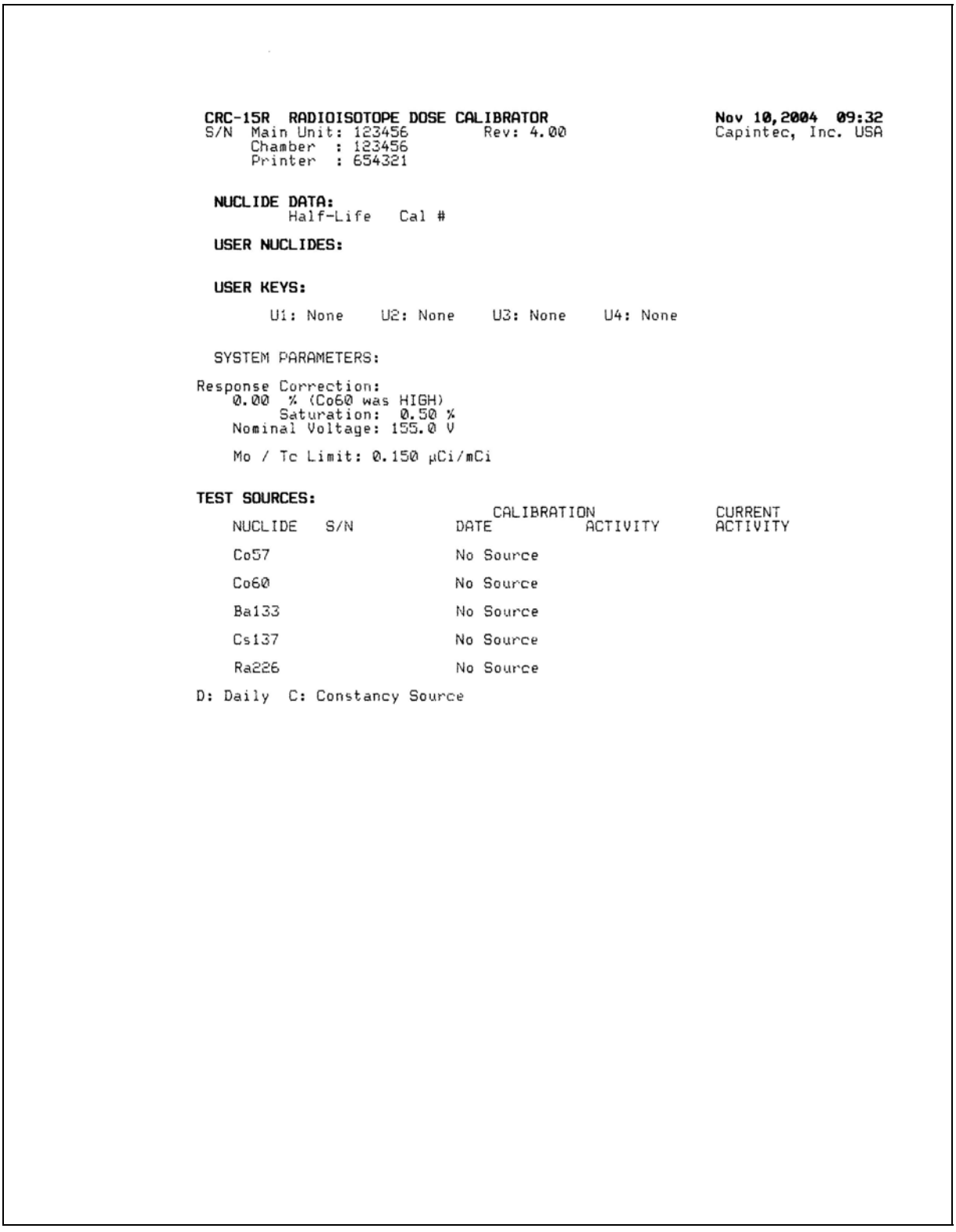


CRC-15R RADIOISOTOPE DOSE CALIBRATOR **Nov 10,2004 09:31**
S/N Main Unit: 123456 Rev: 4.00 Capintec, Inc. USA
Chamber : 123456
Printer : 654321

NUCLIDE DATA:

	Half-Life		Cal #
In116m	54.15	M	974
Ir192	73.83	D	408
K 42	12.36	H	033
K 43	22.30	H	430
Kr79	35.04	H	050
Kr87	76.30	M	250
Mn52	5.591	D	676 ÷2
Mn54	312.5	D	309
Mn56	2.577	H	627
Mo99	65.92	H	165
N 13	9.965	M	457
Na22	2.602	Y	957
Na24	14.96	H	658 ÷2
Nd147	10.98	D	213
Np239	2.355	D	147
O 15	2.040	M	462
Pb203	51.88	H	344
Pb212	10.64	H	101
Ra226	1600.	Y	778
Rb81	4.580	H	270
Rb82	1.273	M	504
Rb84	32.77	D	347
Sb117	2.800	H	082
Sb122	2.700	D	146
Sb124	60.20	D	720
Sc44	3.927	H	938
Sc46	83.79	D	822
Se75	119.8	D	258
Sn113	115.1	D	180
Sr85	64.85	D	193
V 48	15.97	D	569 ÷2
Xe135	9.090	H	085
Y 86	14.74	H	711 ÷2
Y 88	106.6	D	465 ÷2
Yb169	32.03	D	948
Zn65	243.9	D	172
Zn69m	13.76	H	143
MoCAP	65.92	H	204*10
MoCAN	65.92	H	246*10
TcCAPM	6.007	H	042
TcCAPB	6.007	H	031

Figure 7-19 Diagnostics Printout on OKIDATA Printer (page 3 of 4 pages)



CRC-15R RADIOISOTOPE DOSE CALIBRATOR **Nov 10,2004 09:32**
S/N Main Unit: 123456 Rev: 4.00 Capintec, Inc. USA
Chamber : 123456
Printer : 654321

NUCLIDE DATA:
Half-Life Cal #

USER NUCLIDES:

USER KEYS:

U1: None U2: None U3: None U4: None

SYSTEM PARAMETERS:

Response Correction:
0.00 % (Co60 was HIGH)
Saturation: 0.50 %
Nominal Voltage: 155.0 V

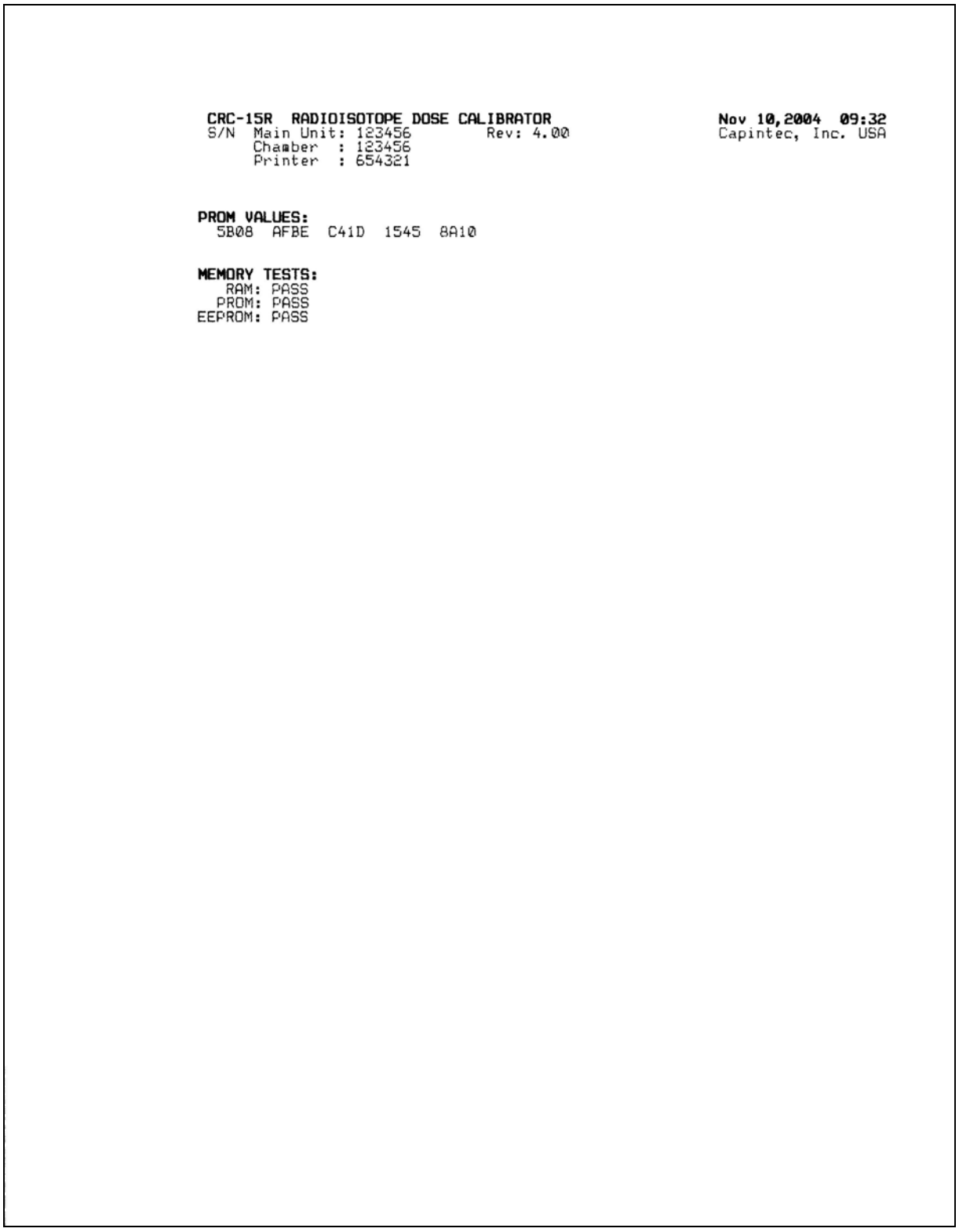
Mo / Tc Limit: 0.150 µCi/mCi

TEST SOURCES:

NUCLIDE	S/N	CALIBRATION DATE	ACTIVITY	CURRENT ACTIVITY
Co57		No Source		
Co60		No Source		
Ba133		No Source		
Cs137		No Source		
Ra226		No Source		

D: Daily C: Constancy Source

Figure 7-19 Diagnostics Printout on OKIDATA Printer (page 4 of 4 pages)



```
CRC-15R  RADIOISOTOPE DOSE CALIBRATOR                Nov 10,2004  09:32
S/N  Main Unit: 123456          Rev: 4.00            Capintec, Inc. USA
     Chamber  : 123456
     Printer  : 654321


PROM VALUES:
  5B08  AFBE  C41D  1545  8A10

MEMORY TESTS:
   RAM: PASS
  PROM: PASS
EEPROM: PASS
```

CHAPTER 8

MEASUREMENT PROCEDURES

GENERAL

Instructions for measuring a sample are given in this section.

The Measurement Screen is shown below.

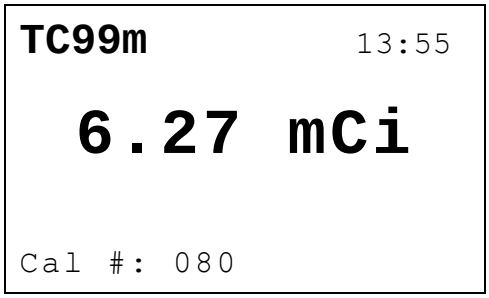


Figure 8-1 Measurement Screen

MEASUREMENT PROCEDURES

Note: *In order to obtain a correct reading for a Vial or Syringe, the supplied liner and dipper must be used to achieve the correct geometry. If the source is contained in a different type of container, then contact Capintec, Inc. for further assistance.*

General Activity Measurement Procedure

To measure the activity of a sample:
Insert sample into the Chamber.
Specify nuclide.

To print a record of the measurement:
Press **ENTER**.

To find out what the activity will be at a different time:
Press **TIME**.

Specifying Nuclide

A nuclide may be specified via one of the pre-set nuclide keys, one of the user keys or via the **NUCL** key.

Pre-Set Nuclide Key:

Press one of the 9 pre-set Nuclide Keys.

Co57 Ga67 Tc99m F18 In111 I123 I131 Xe133 Tl201

User Key:

Press one of the 4 User Assigned Nuclide Keys.

U1 U2 U3 U4

Note: *Before using one of these keys, a nuclide must be assigned to the key. (See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: USER KEY ASSIGNMENT)*

NUCL Key:

Press **NUCL**.

"SPECIFY NUCLIDE" is displayed.

Input the nuclide name via the number/letter keys (only numbers will appear).

Press **ENTER** when done.

The entire name does not have to be input. If the nuclide is not uniquely specified, a list of possibilities will appear. (If there are more than 10 possibilities, "SPECIFY FURTHER" will appear.)

Input the number corresponding to the desired nuclide and press **ENTER**. If **NUCL** was accidentally pressed, press **ENTER** without any input.

Entering Calibration Number

A measurement may also be made by entering a calibration number instead of selecting a nuclide from memory.

Press **CAL#**.

"ENTER CALIBRATION #" is displayed.

Input the desired calibration number and press **ENTER**.

A calibration number may include a multiplication sign (* on the keyboard, displayed as X) or a division sign. However, the chamber is always direct reading and the multiplication or division sign is only used to be consistent with existing calibration numbers.

If **CAL#** was accidentally pressed, press **HOME** to return to Figure 8-1.

Selecting Range

The CRC®-15R is auto ranging over 3 ranges. However, the ranges can be cycled through manually by using the **UP (↖)** and **DOWN (↘) ARROW** keys. When the unit is first powered on, the display will be in the high activity range (.xx mCi).

To display greater accuracy with the medium activity range (x. µCi), press the **DOWN ARROW (↘)**.

For the greatest accuracy, select the low activity range (x.xx µCi) by pressing the **DOWN ARROW (↘)** again.

Pressing the **DOWN ARROW (↘)** a third time will keep the unit in the low activity range (x.xx µCi) but with a longer averaging time.

Pressing the **UP ARROW (↖)** will reverse the process.

When **HOME** is pressed, the display reverts to the power up range (high activity range).

ACTIVITY AT A DIFFERENT TIME

It is often desirable to know the activity of the sample at another time (usually in the future). When another date / time is chosen, the activity at that date and time will be displayed (and printed) along with the measured activity.

The feature is only available when a nuclide is specified because the half-life of the nuclide must be known.

Press **TIME**.

The calibration number is erased and the current time and date appear in the order: hour, minute, Day, Month, Year. The hour is highlighted.

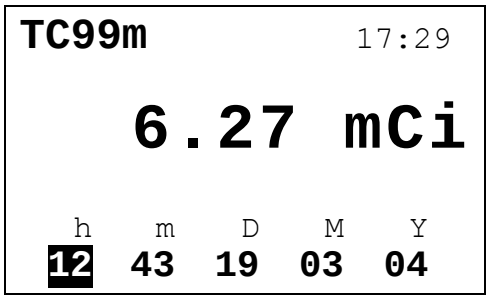


Figure 8-2 Time / Date Input Screen

Use the **ARROW** keys to highlight the field (hour, min, Day, Month, Year) that you want to change, then use the numeric keypad to change the value of that field.

Press **ENTER** when the desired time and date is displayed.

The activity at the input day and time is displayed.

If only the time was changed, the new time will be shown as in the figure below.

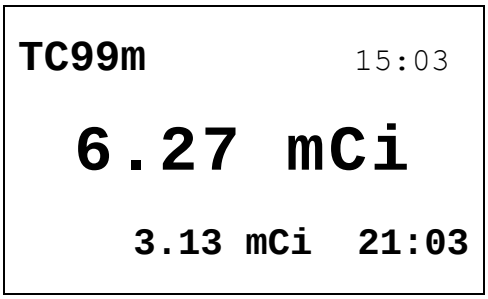


Figure 8-3 Future Activity – Same Day

If the day was changed, the new time and date will be shown:

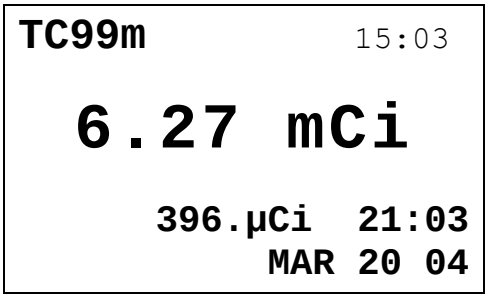


Figure 8-4 Future Activity – Different Day

PRINTING A RECORD OF THE MEASUREMENT

To print a record of the measurement, follow the directions for the selected printer:

OKIDATA Printer

Ticket Chosen:

- If the printer is set up for continuous feed, press **PARK** (on printer)
- Move right hand lever back to single sheet
- Place ticket between guides with CAPINTEC, INC down and facing away from you. The ticket will automatically be advanced into the printer.
- Press the **SEL** pad on the printer so that the **SEL** light is lit.
- Press **ENTER** (on keyboard).

Single Line Chosen:

- Verify that the **SEL** light is lit.
- Press **ENTER**.

Roll Printer

- Press **ENTER**.

Slip Printer

- If the **RELEASE** light (on printer) is not lit, press **RELEASE** (on printer).
- Place Ticket in printer, face up.
- Slide the ticket under the mechanism until the **PAPER OUT** light is off.
- Press **ENTER** (on keyboard).

MOLY ASSAY

The CRC®-15R steps the user through a Moly Assay procedure. The assay may be performed in the CAPMAC or the CANISTER.

If one method (CAPMAC or CANISTER) is to be used all the time, choose the method in Utilities (See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: MOLY ASSAY METHOD).

To perform a Moly Assay, press **Mo Assay** key while in the Measurement Screen.

If the assay method has not been uniquely specified, you must choose the method.

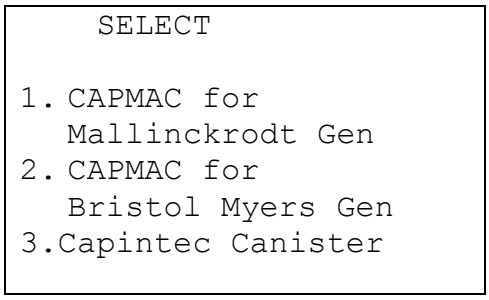


Figure 8-5 Moly Assay Method Selection Screen

Select the method to be used for the current test only.

If only CAPMAC or only CANISTER has been chosen in utilities, this screen will be skipped.

Mo99 Background

Measuring the background for Mo99 is optional. This background will only be used for the current assay. If it is skipped, the background previously measured by pressing **BKG** or during the Daily Test will be used.

The following examples are for CAPMAC. CANISTER will be exactly the same except that the screens will prompt for measurements in the CANISTER.

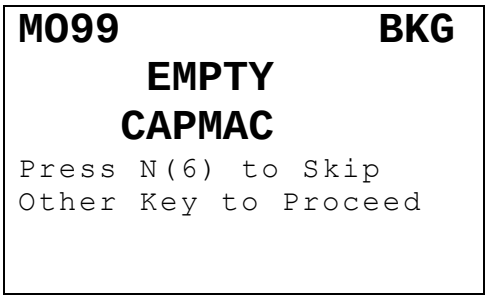


Figure 8-6 Moly Assay Background Choice Screen

Press **N** if you don't want to measure background with the CAPMAC or CANISTER. You will go directly to Mo99 Assay.

Press any other key (except **HOME**) to begin Mo background measurement (Moly Assay Instruction Screen).

Measuring Mo99 background is very similar to measuring background via **BKG** key or Daily Test.

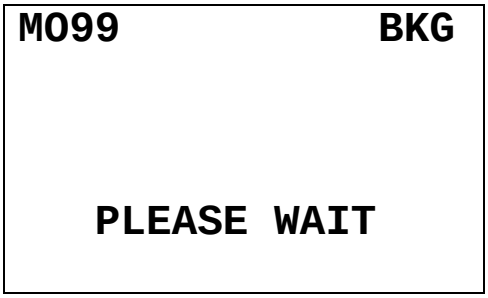


Figure 8-7 Moly Assay Background Wait Screen

When a measurement is ready:

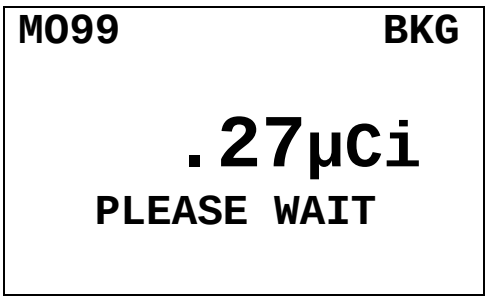


Figure 8-8 Moly Assay Background Measurement Ready Screen

When enough measurements are made, you may accept the measurement and continue:

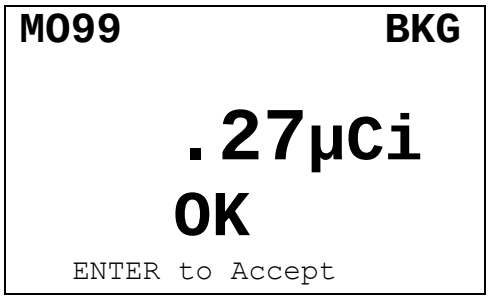


Figure 8-9 Moly Assay Background Measurement Accept Screen

Press **ENTER** to accept measurement and continue to Mo99 Assay.

Note: *The activity will be tested to see if it's too high the same way that Background is tested.*

Mo99 Assay

You will now be instructed to measure the eluate in the CAPMAC or CANISTER.

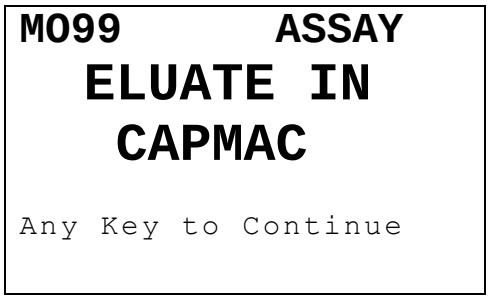


Figure 8-10 Moly Assay Instruction Screen

Press any key (except **HOME**) to begin the measurement.

Since this is also a measurement of a very low activity, the screens are similar to background:

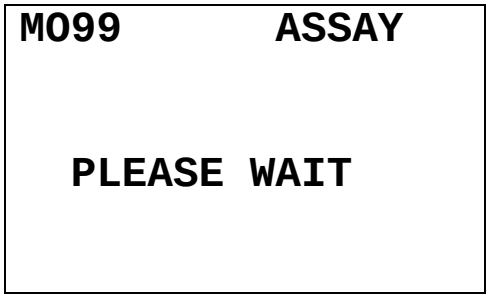


Figure 8-11 Moly Assay Wait Screen

When a measurement is ready:

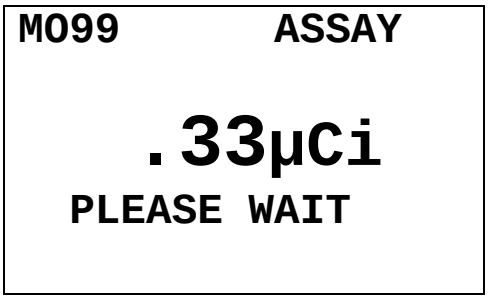


Figure 8-12 Moly Assay Ready Screen

When enough measurements are made, then you may accept the measurement and continue:

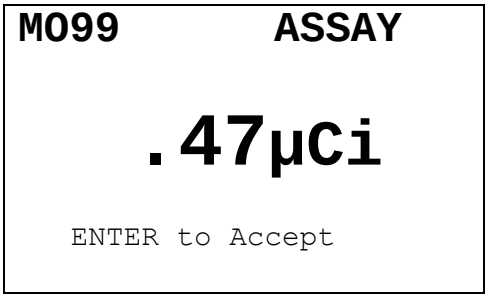


Figure 8-13 Moly Assay Accept Screen

Press **ENTER** to accept measurement and continue to Tc99m Assay.

Note: *The activity will be tested to see if it's too high the same way that Mo99 Background is tested.*

Tc99m Assay

The Tc99m Assay is performed next:

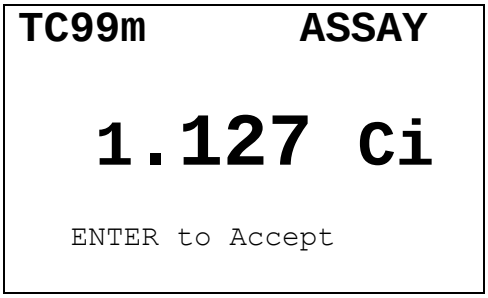


Figure 8-14 Tc99m Measurement

Press **ENTER** to accept the measurement.

Note: *An error message (ACTIVITY TOO LOW – Any Key to Continue) will appear if the Tc99m activity is too low (below 1 mCi).*

Moly Assay Results

The Mo99/Tc99m ratio is calculated and displayed.

The ratio is compared to the allowable value (which can be changed in Utilities) and the time when the ratio will exceed this limit is calculated.

If the calculated time limit is less than 12 hours, a usage message is displayed depending upon the useable time for the elution. An example of such a case is given below:

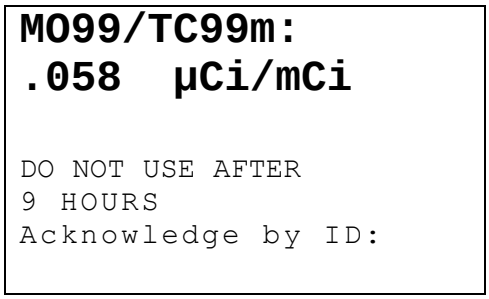


Figure 8-15 Mo99/Tc99m Exceeding Limit Screen

Input your ID number and press **ENTER** to acknowledge the usage message, erase it. The next screen requests the user to enter the volume of the eluate in ml. This is the screen that will appear if the ratio is within limits and is useable for more than 12 hours.

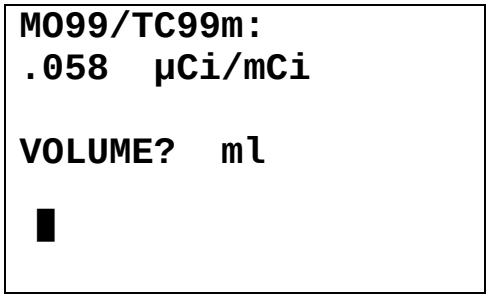


Figure 8-16 Mo99/Tc99m with Volume Entry Screen

Enter the volume of the elution and press **ENTER**.

The concentration of the elution is calculated and displayed.

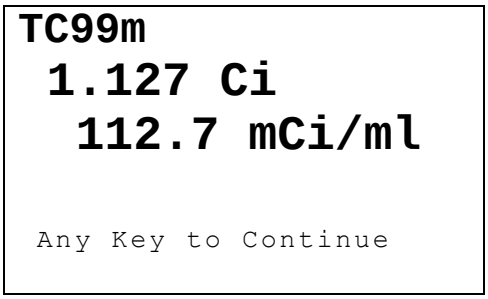


Figure 8-17 Elution Concentration Screen

Press any key (except **HOME**) to print a ticket with the details of the assay.

You will then be asked if you want to print again. If **Y** is pressed, another ticket is printed. If **N** is pressed, you will be returned to the Measurement Screen.

CHAPTER 9

CALCULATION UTILITIES

GENERAL

Two calculation utilities are provided with the CRC®-15R: Conversion between Ci and Bq and Decay Calculation. They are both accessed via the Utility Menu.

CONVERSION BETWEEN Ci and Bq (Ci ↔ Bq)

An activity is entered in Curies and the value is displayed in Becquerels or an activity is entered in Becquerels and the value is displayed in Curies.

From the *Utility Menu*, press **1** for *Ci ↔ Bq CONV*.

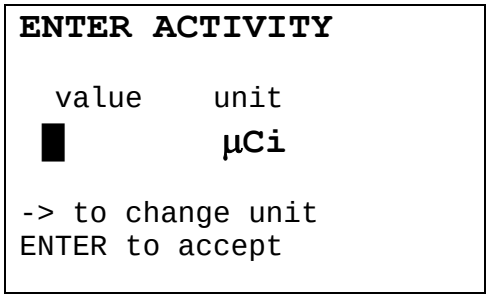


Figure 9-1 Ci ↔ Bq Activity Entry Screen

Enter the value of the activity to be converted and then press the **RIGHT ARROW** (➘). Use the arrow keys to scroll the activity units: μCi, GBq, MBq Ci, or mCi. If the value needs to be changed, press **CE**.

When the value and unit are correct, press **ENTER**.

The result screen will appear (in the example 100 mCi was entered):

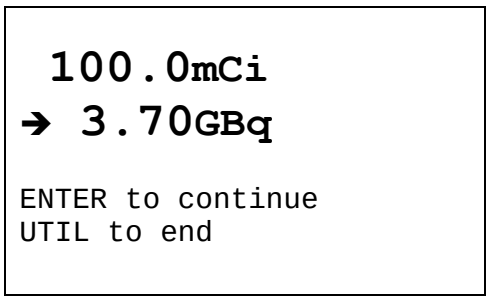


Figure 9-2 Ci ↔ Bq Result Screen

Press **ENTER** to perform another conversion. Press **UTIL** to return to the *Utility Menu*.

DECAY CALCULATION

This utility is used to calculate the activity of a source at a different time (either in the past or the future).

From the *Utility Menu*, press **2** for *DECAY CALC*.

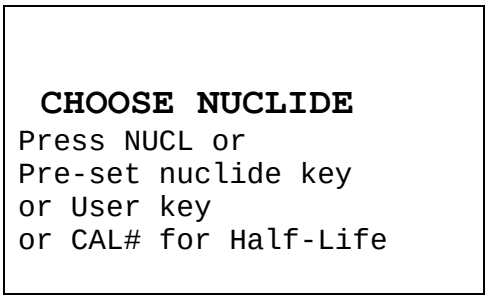


Figure 9-3 Choose Nuclide for Decay Calculation Screen

Calculations for Nuclides in Memory

Choose the nuclide via the **NUCL** key, one of the Pre-Set Nuclide keys or an Assigned User key.

In the example below, the pre-set nuclide key **Co57** was pressed. The original activity of Co57 is 100mCi on Dec 2, 2002 and we want to know the activity today (Mar 19, 2004).

The activity entry screen will now appear with the nuclide name and half-life displayed.

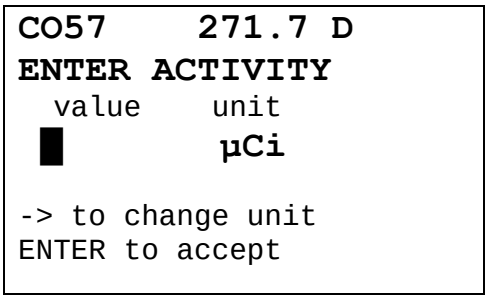


Figure 9-4 Decay Calculation Activity Entry Screen

Enter the value of the activity and then press the **RIGHT ARROW** (↘). Use the arrow keys to scroll the activity units: µCi, GBq, MBq, Ci, or mCi. If the value needs to be changed, press the **CE** key.

When the value and unit are correct, press **ENTER**.

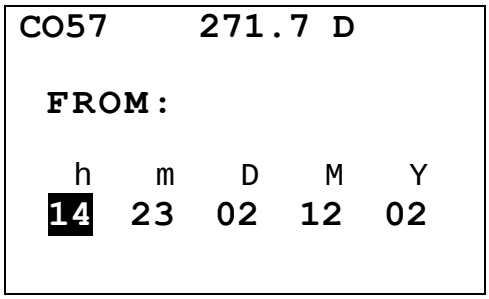


Figure 9-5 Decay Calculation Activity Starting Time/Date Screen

The current time/date will appear. If the starting time/date is “now”, press **ENTER**. Otherwise, use the arrow keys to change the date and/or time and press **ENTER**.

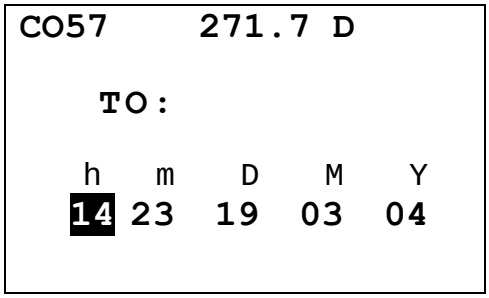


Figure 9-6 Decay Calculation Activity Ending Time/Date Screen

The current time/date will appear. If the ending time/date is “now”, press **ENTER**. Otherwise, use the arrow keys to change the date and/or time and press **ENTER**.

The results screen will appear:

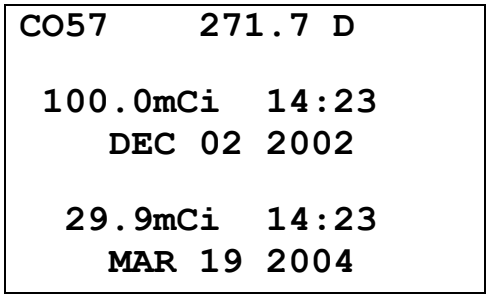


Figure 9-7 Decay Calculation Result Screen

Press any key when finished viewing the results. You will be returned to the Choose Nuclide for Decay Calculation Screen.

To exit Decay Calculation, press **UTIL** to return to the *Utility Menu* or **HOME** to return to the Measurement Screen.

Calculations for Nuclides not in Memory

If you want to perform the decay calculation for a nuclide which is not in memory, press the **CAL#** key.

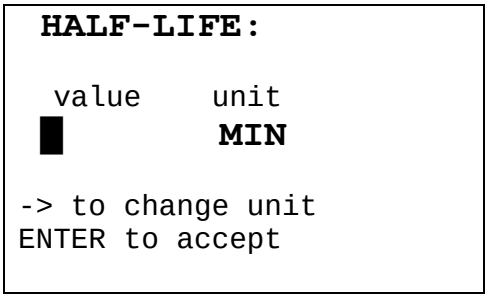


Figure 9-8 Entering Half-life for Decay Calculation Screen

Input the value of the half-life and then press the **RIGHT ARROW** (↘). Use the arrow keys to scroll the half-life from Min to Hour to Day to Year. If the value needs to be changed, press **CE**.

When the value and unit are correct, press **ENTER**.

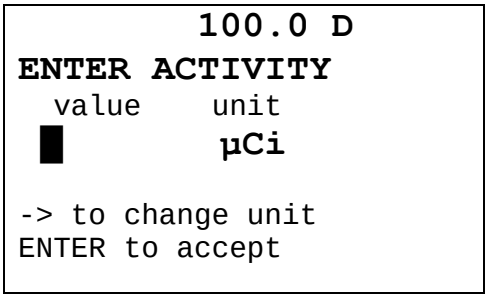


Figure 9-9 Decay Calculation Activity Entry Screen

Input the value of the activity and then press the **RIGHT ARROW** (↘). Use the arrow keys to scroll the activity units: µCi, GBq, MBq, Ci, or mCi. If the value needs to be changed, press **CE**.

When the value and unit are correct, press **ENTER**.

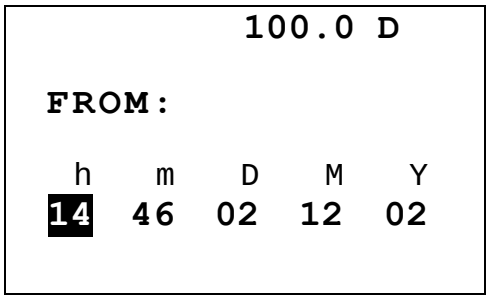


Figure 9-10 Decay Calculation Activity Starting Time / Date Screen

The current time/date will appear. If the starting time/date is “now”, press **ENTER**. Otherwise, use the arrow keys to change the date and/or time and press **ENTER**.

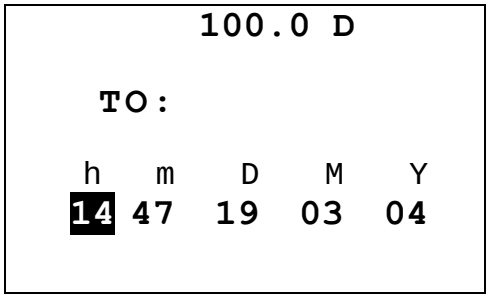


Figure 9-11 Decay Calculation Activity Ending Time/Date Screen

The current time/date will appear. If the ending time/date is “now”, press **ENTER**. Otherwise, use the arrow keys to change the date and/or time and press **ENTER**.

The results screen will appear:

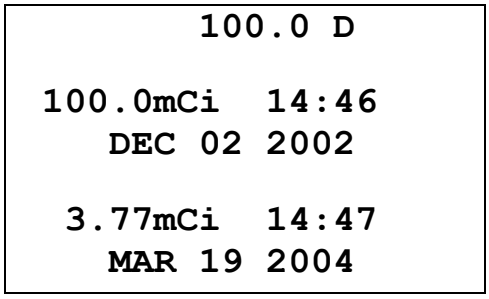


Figure 9-12 Decay Calculation Result Screen

Press any key when finished viewing the results. You will be returned to the Choose Nuclide for Decay Calculation Screen.

To exit Decay Calculation, press **UTIL** to return to the *Utility Menu* or **HOME** to return to the Measurement Screen.

CHAPTER 10

CLEANING AND MAINTENANCE

GENERAL

This chapter provides the information necessary for the user to perform the basic maintenance of instrument cleaning, fuse replacement, and general preventative maintenance. There are no internal adjustments or calibration settings which may be done by the user within the conditions of the warranty.

REFER ALL SERVICING TO A QUALIFIED SERVICE REPRESENTATIVE !

It is recommended that periodic (every three to five years) re-calibration of the CRC®-15R readout unit and chamber be performed by Capintec's Authorized Service Center to guarantee the instrument's high reliability is maintained. Contact the Capintec's Authorized Service Center in Pittsburgh for servicing or re-calibration at 1-800-227-6832.

CLEANING INSTRUCTIONS

WARNING !

TO AVOID ELECTRICAL SHOCK OR DAMAGING OF THE CRC®-15R, NEVER GET WATER OR LIQUIDS INSIDE THE CHAMBER HOUSING OR THE READOUT ENCLOSURE.

DO NOT USE AN AEROSOL DISPENSER TO SPRAY THE EQUIPMENT WITH ANY CLEANING SOLUTION OR LIQUID.

TO AVOID DAMAGING THE CASE OR DISPLAY SCREEN, DO NOT USE AROMATIC HYDROCARBONS, CHLORINATED SOLVENTS, OR METHANOL-BASED CLEANING SOLUTIONS.

If the CRC®-15R readout or chamber requires cleaning, wipe it down with a soft cloth that is lightly dampened with water, window cleaner, or a mild detergent.

For the printer, refer to the printer owner's manual for proper cleaning procedures.

For the Remote Display, refer to the Remote Display owner's manual for proper cleaning procedures.

PREVENTATIVE MAINTENANCE

The Quality Assurance Tests described in CHAPTER 6: ACCEPTANCE & QUALITY ASSURANCE TESTS, should be performed periodically as stated.

Tests must be performed in an environment where the temperature is stable within a range of +50°F to +85°F (+10°C to +30°C) and the maximum relative humidity is 90% non-condensing. The unit should be powered-up for at least one-half hour prior to performing any measurements. No other precautions need to be observed.

CAUTION

If these environmental requirements are not followed, the instrument may display erroneous readings.

If the unit fails to pass Autocalibration Test or any other test, the user **should not** attempt to perform any adjustments to the system. In this event, please contact Capintec for further assistance.

The Quality Assurance tests should be immediately performed if:

- The equipment has been subjected to extreme physical stress,
- Liquids enter the readout unit, and/or chamber, or
- Any cable shows signs of damage

SERVICING

The system is covered by a one year limited warranty, under normal conditions of use.

Other than the Readout Unit fuses (see Fuse Servicing in this chapter), there are no user serviceable parts contained in the system.

Every five years, the system should be returned to Capintec's Authorized Service Center for a complete verification.

CAPINTEC, Inc.
540 Alpha Drive
Pittsburgh, PA 15238
Phone (412) 963-1988, 1-800-227-6832
Fax (412) 963-0610

DISPOSAL

The following items should be taken into consideration before disposing.

The unit contains two types of hazardous items:

1. Lead – the shielding around the chamber.
2. Lithium Battery – contained on the HPC/CPU printed circuit board inside of the readout unit.

These items should be disposed of in accordance with local and national regulations.

FUSE SERVICING

Readout Fuses

CAUTION
For continued protection, replace only with same type and rating of fuse(s)

Two fuses are located in the power entry module next to the power cord connector on the back panel of the Readout Unit. These fuses are rated at F 1.6AH 250 Volts as specified on the label located directly below the power entry module.

To change these fuses:

1. Turn off the CRC®-15R power switch and unplug the line cord from the power entry module.
2. Insert the tip of a small flat bladed screw driver into the notch of the power entry module just to the left of the switch. Twist the screw driver to open the fuse cover door. (See Figure 10-1).
3. To remove the first of the two fuse carriers, insert the tip of the screw driver behind the arrow and pull it out. Repeat this process for the second fuse.
4. Remove the blown fuse(s) from the carrier and replace it(them) with F 1.6AH 250 Volt fuse(s).
5. Re-insert the fuse carriers with the arrows pointing up.

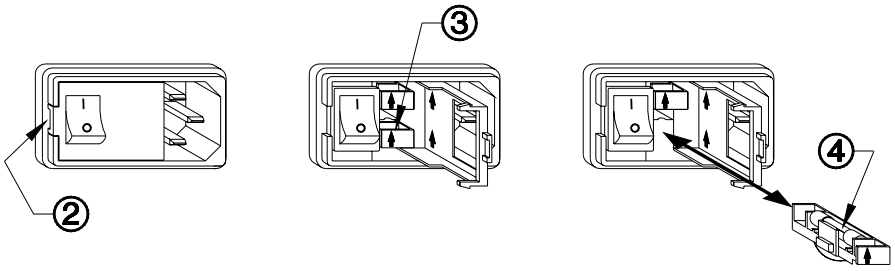


Figure 10-1 Readout Fuse Replacement

6. Close the fuse cover door and snap it into place.
7. Replace the line cord and turn on the power switch for the CRC®-15R.
8. Verify the CRC®-15R System is functioning correctly by performing the Daily Test as specified in CHAPTER 6: ACCEPTANCE & QUALITY ASSURANCE TESTS.

Printer Fuse

The printer fuse is not accessible from the outside of the printer case and must be replaced by a qualified service representative.

TROUBLESHOOTING

Some problems may be very easy to diagnose and correct in the field with little or no equipment. If a problem should occur, check here before you call for service. You may be able to save a considerable amount of time and money.

Nothing appears on the display.

- Make sure calibrator is plugged into a live outlet and is turned on.
- Check fuse and replace if necessary. See: FUSE SERVICING.

Nothing happens when any key is pressed.

- One of the keys may be stuck. Try wiggling each key.
- A brief power line disruption may have caused the program to “lose its place”. Try turning the power off and then on again.

Buzzer buzzes continuously.

- A brief power line disruption may have caused the program to “lose its place”. Try turning the power off and then on again. If the buzzing continues, turn the power off and consult the factory. DO NOT leave the unit buzzing longer than necessary.

High background indication.

- Chamber Well, liner, or dipper may have become contaminated. See: CHAPTER 6: ACCEPTANCE & QUALITY ASSURANCE TESTS, SECTION: CONTAMINATION TEST.
- Background may actually be high. Check by removing the dipper and placing a lead sheet over the top of the well.

Zero activity is indicated with a source in the well.

- System may not be in lowest range. Try pressing **SPC**.

Readings appear overly noisy for low activities.

- System may not be in long averaging period. Try pressing **SPC** twice.
- Make sure that the chamber is on a solid surface and is not subject to vibration.

Indication of significant negative activity.

- Background level may have changed. Re-do the Background Adjust. See: CHAPTER 7: TESTS, SECTION: BACKGROUND.

Printer prints junk or prints with incorrect spacing.

- Make sure that the Printer Menu Setup is correct. See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: PRINTING.

Print head hangs up when printing tickets.

- Lever on left side of print head must be set to position 2.

Printer will not respond.

- Make sure printer is plugged into a live outlet, turned on, and "selected".
- Make sure that either paper or a ticket is in the paper path.
- Run the Diagnostic Test and make sure that the system expects to have a printer. If not, add it to the Factory Set-up data.
- Make sure that the Printer Menu Setup is correct See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: PRINTING.

ACCESSORIES AND REPLACEMENT PARTS

The following accessories and replacement parts are available from Capintec. Call Capintec's Authorized Service Center at 1-800-227-6832 for answers to your questions or to place an order.

- CAPMAC Moly Assay Kit (specify generator).....CALL
- Dose Calibrator Reference Sources.....CALL
- Shielded products for PET.....CALL
- Standard Moly Assay Kit 5130-0006
- Calicheck Linearity Test Kit 5120-2144
- Ionization Chamber Well Inserts (liners).....7300-2004
- Plastic Sample Holders (dippers) 7300-2005
- Environmental Shield.....7300-2450
- Flush Mount Mounting Flange 7310-2307
- Shielded Platform with 2mm shielded glass 5150-3010
- Shielded Platform with 4mm shielded glass 5150-3011
- Dosilift™ remote lowering/raising of syringes or vials 5120-2175
- Remote Display 5130-2082
- RS-232 Port.....5130-0151
- Keyboard Membrane 7800-2164
- Okidata 320 Ticket and Report Printer 5110-1150
- Epson Roll Printer.....5430-0058
- Epson Ticket Printer 5430-0100
- Printer Ribbons.....CALL
- Multi-part Tickets, Paper, etc.....CALL
- Additional copies of Owner's Manual 9250-0038

Note: *Circuit diagrams, component parts lists, descriptions and calibration instructions are available to appropriately qualified personnel.*

SHIPPING

If for any reason the CRC®-15R must be returned to Capintec, the shipping carton must contain the following or equivalent labeling as shown in figures 10-2 and 10-3.
Label stipulating the maximum environmental conditions for safe storage and shipment.

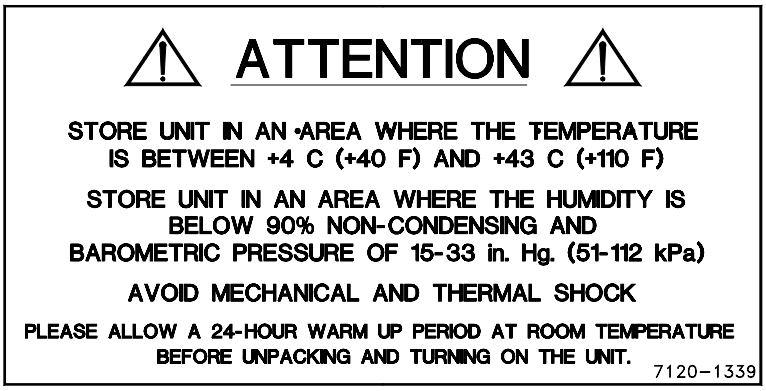

ATTENTION
STORE UNIT IN AN AREA WHERE THE TEMPERATURE IS BETWEEN +4 C (+40 F) AND +43 C (+110 F)
STORE UNIT IN AN AREA WHERE THE HUMIDITY IS BELOW 90% NON-CONDENSING AND BAROMETRIC PRESSURE OF 15-33 in. Hg. (51-112 kPa)
AVOID MECHANICAL AND THERMAL SHOCK
PLEASE ALLOW A 24-HOUR WARM UP PERIOD AT ROOM TEMPERATURE BEFORE UNPACKING AND TURNING ON THE UNIT.
7120-1339

Figure 10-2

Figure 10-3

In order to ship this product, all appropriate Department of Transportation (DOT) and, if shipped by air, the International Aviation and Transportation Administration (IATA) requirements for the shipment of the pressurized (12 Atmosphere) Ionization Chamber Detector must be met.

APPENDIX I

PRINCIPLE OF THE CALIBRATOR

GENERAL

The definition of activity, the basic principle of the calibrator, and the detailed discussion on the calibration are presented in this section.

DEFINITION OF ACTIVITY

ACTIVITY

Activity is defined as:

The activity, A, of a quantity of a radioactive nuclide is the quotient of dN by dt, where dN is the number of spontaneous nuclear transformations which occur in this quantity in time interval dt.

$$A = \frac{dN}{dt}$$

The special unit of activity is Curie (Ci):

$1\ Ci = 3.7 \times 10^{10}$ s^{-1} (exactly)

Note: *The term nuclear transformation is meant to designate a change of nuclide of an isomeric transition. (ICRU REPORT 19, 1971)*

The SI (International System of Units) unit for activity is the reciprocal second, s^{-1}, and is named the Becquerel (Bq), i.e.;

1 Bq = 1 Nuclear Transformation per second

$1\ Ci = 3.7 \times 10^{10}\ Bq$

TYPES OF TRANSFORMATIONS

α-decay

The nucleus emits a helium nucleus (α-particle).

Electron Capture (ε-decay)

The nucleus captures one of its own orbital electrons, usually from the K shell, and a neutrino is emitted.

β^- Decay

The nucleus emits an electron (β^- particle), and a neutrino.

β^+ decay

The nucleus emits a positron (β^+ particle) and a neutrino.

Nuclear Transition

A photon (electromagnetic radiation, γ-decay), electron (Internal Conversion Electron Emission, CE or electron-positron pair (Internal-pair emission, e±) is emitted by a nucleus in a transition from a higher to lower energy state. No nuclear transformation occurs if there is no change in the atomic number nor the mass number. The de-excitation of a nucleus in its unstable state (metastable state) is, however, included in the definition of activity.

MEASUREMENT OF ACTIVITY

A Nuclear Transformation is always associated with one or more of the following types of radiation:

α
β^+, β^- and ν
Photons

We can, therefore, measure activity by detecting one or more of the above radiations.

α-PARTICLE RADIATION

The most energetic α-particle emitted by a radionuclide has an energy of less than 10 MeV, which corresponds to a range of about 10 mg/cm^2 (8 cm in air). Because of its short range, an α-particle from a radionuclide cannot penetrate to the ionization chamber's sensitive volume and therefore, cannot be detected.

All α-decays, however, are accompanied by photon radiation as the daughter nucleus decays to its ground state. The activity of a nuclide which decays through a radiation can therefore, be measured by detecting the associated photon radiation.

β^+ RADIATION

β^+ particle (positron) emitted from a nucleus comes to rest in the media by losing its kinetic energy mainly by direct ionization processes and then annihilates with an electron to produce two photons of 511 keV each. These photons are easily detected by the ionization chamber. De-excitation photons are also associated with β^+ decay.

β^- RADIATION

The ejected electron loses kinetic energy in matter mainly by direct ionization.

The range of most emitted β's is very short. It should be noted that in β^+ and β^- emission, the emitted electron or positron has a continuous energy spectrum, which ranges from E_{max} to zero, where E_{max} is the maximum transition energy. β-rays (with the exception of a small portion of very high energy βs) will be stopped in the sample, in the chamber liner, and in the chamber wall.

As the electron decelerates, it also produces continuous low energy photon emission called Bremsstrahlung (stopping or braking radiation).

Many radionuclides that decay by β emission also emit de-excitation photons (x-rays, γ-rays), which can be detected by the ionization chamber.

ELECTRON CAPTURE

The actual electron capture process cannot be detected since the electron is not emitted but is captured by the nucleus. The capture of the orbital electron, however, leaves a vacancy in the atomic orbital shell, resulting in x-rays as the atom de-excites.

The energy of k x-ray is approximately

$$E_k \approx \frac{Z^2}{100} \quad \text{[keV]}$$

where Z is the atomic number of the daughter nucleus.

γ-rays are also often given off as the daughter nucleus de-excites.

PHOTON RADIATION

Photon radiation is associated with most nuclear transformations. A high energy photon interacts with matter very weakly. Photon intensity is therefore, not altered substantially by the surrounding media, i.e., measurement of activity can be accomplished with a minimum of disturbance from the sample configuration.

As can be seen from the above, in all cases we are detecting photons. We will therefore, discuss photons and their interactions with matter in detail.

PHOTONS

Photon is the general term for a quantum of radiation. Photons are classified according to their method of production.

γ-Rays

Photons resulting from nuclear transitions, nuclear reaction or annihilation of particles (e.g., electron-positron annihilation) are called Gamma-rays (γ-rays). Radioisotope sources

(radionuclides) are the most common means of γ-ray production. Radioisotope γ-sources emit photons of one or more discrete energies.

X-Rays

X-rays are associated with the deceleration of electrons or with orbital electron transitions in atoms.

The radiation from a γ-source is often accompanied by characteristic x-rays from transitions of the orbital electrons in the daughter atom.

Bremsstrahlung

When very fast electrons are brought to rest in a medium (or pass through media) a continuous low energy photon spectrum occurs. This is called Bremsstrahlung ("stopping or braking radiation").

The intensity and the energy spectrum of Bremsstrahlung are highly dependent upon the source configuration and media surrounding the sample. (See Appendix of this manual for more detailed discussion on Bremsstrahlung.)

In this manual, the term photon will be used when the method of production of the radiation has no bearing on the discussion.

INTERACTIONS OF PHOTONS WITH MATTER

There are three mechanisms by which photons can interact with matter and, thus, deposit their energy. These mechanisms are: Photoelectric effect, Compton effect, and, pair production. The energy of the photon determines which process (or processes) are possible.

Photoelectric Effect

The photoelectric effect is an interaction between a photon and an electron which is bound to an atom. In the photoelectric process, the photon is absorbed by the atom and a bound electron is ejected. The kinetic energy of the ejected electron is equal to the photon energy minus the binding energy of the electron. The binding energy of an electron is the energy which must be supplied in order to remove the electron from the atom.

In nuclear medicine, we are interested in photon energies of 20 keV or greater. At these energies, all the electrons in the materials used for the chambers are able to participate in the photoelectric process. The photoelectric effect is the most important process at low energies. However, for photon energies much greater than electron binding energies, the processes described below become more important and the number of photoelectric interactions occurring becomes small. At a given energy, the number of photoelectric interactions per unit mass varies as the 4th power of the atomic number and is inversely proportional to the atomic weight of the medium (Z^4/A).

Compton Effect

The Compton Effect is a collision between a photon and an electron which can be considered unbound. An electron can be considered to be unbound (or "free") if the energy of the incident photon is much greater than the binding energy of the electron. The kinetic energy of the scattered electron is not constant, but is a function of the angle through which it is scattered. The scattered photon must interact again in order to impart all of its energy to the medium.

The Compton effect is the dominant process for photon energies from 100 keV to about 10 MeV in the region of the atomic numbers for detector materials. At 100 keV, the maximum kinetic energy of the scattered electron is about 30 percent of that of the incident photon; at 1 MeV, it is about 80 per cent; and at 10 MeV, it is about 98 percent. The number of Compton interactions per unit mass varies directly as the atomic number and inversely as the atomic weight of the medium (Z/A).

Pair Production

The process of pair production is difficult to comprehend because it is strictly a relativistic quantum mechanical effect. What is observed to take place is that in the presence of the electric field of a nucleus, the incident photon disappears and an electron and a positron appear. (A positron is a particle with the same properties as an electron, except that it has a positive charge.)

In order to produce an electron-positron pair, the incident photon must have an energy of at least twice the mass of an electron, i.e., 1.022 MeV. This process dominates for very high energies, that is, above about 10 MeV. The number of pair production interactions per unit mass is proportional to the square of the atomic number and inversely proportional to the atomic weight of the medium (Z^2/A).

IONIZATION CHAMBER MEASURING PROCESS

An ionization chamber consists of two or more electrodes. The electrodes confine a volume of gas and collect the charge (ions) produced by radiation within the volume. Thus, ionization chambers can be used to measure radiation fields if the relationship between the radiation field and the charge produced is known.

The radiation enters the chamber through the chamber wall and interacts with the gas in the chamber or with the chamber wall. It must be pointed out that photons cannot produce ionization directly, but must first interact with the chamber material (gas and wall) producing electrons. That is, through a series of interactions, the photon transfers its energy to one or more electrons.

The electron is slowed down through collisions with the chamber gas (argon). The collisions knock electrons off the molecules producing positive ions (this is the ionization process).

The collection voltage across the chamber sets up an electric field. The positive ions will drift towards the negative electrode and the electron (and negative ions if they are formed) will drift towards the positive electrode, thus producing a current. The electronic circuitry then measures either the current or the total charge produced during the period of interest.

The number of ions produced in the chamber is directly related to the energy deposited in the chamber by the radiation.

DETERMINING CALIBRATION SETTING NUMBERS

A method of determining a calibration setting number is described in this section.[1]

RESPONSE and Sensitivity

It is very convenient to express the response of the detector to a radioisotope, A, relative to that of a standard reference material, e.g. Co60.

$$R_A \equiv \frac{\left(\frac{\text{Detector Output due to Sample A}}{\text{Activity of Sample A}}\right)}{\left(\frac{\text{Detector Output due to SRM Co60}}{\text{Certified Activity of SRM Co60}}\right)} \qquad (1)$$

The sensitivity of the detector for a photon of energy E_i is defined as:

$$S_i \equiv \frac{\text{Detector Output due to } 3.7\times10^{10} \text{ Photons of } E_i}{\text{Dtector Output due to one Curie of Co - 60}} \qquad (2)$$

The detector response and the sensitivity have the following relation:

$$R_i \equiv \sum_i I_i S_i \qquad (3)$$

Where I_i is the intensity of the photon whose energy is E_i.

The procedure is to measure the response of the detector to all the available primary standard samples and to establish the sensitivity of the detector as a function of photon energy so as to satisfy equation (3) for all standards.

Once the sensitivity curve has been determined, the response of the detector to any radioisotope may be calculated using equation (3), provided that the decay data are known.

The sensitivity curve for a CRC®-ionization chamber is given in Figure A1-1.

The figure depicts the sensitivity of the ionization chamber as a function of photon energy up to 1.9 MeV. Above a photon energy of 200 keV, the ionization in the chamber is mainly due to electrons resulting from Compton scattering of photons by the filling gas (argon) and the chamber walls (aluminum).

[1] See Suzuki, A., Suzuki M.N., and Weis A.M.: Analysis of a Radioisotope Calibrator; Journal of Nuclear Medicine Technology Dec. 1976 for more detailed discussions.

The peak in the low-energy region of the sensitivity curve is due to the rapid increase in photoelectric effect as photon energy decreases and to the attenuation of low energy photons by the sample holder, the chamber liner and the chamber walls, as well as the absorption of photons in the sample material and its container.

Although a significant fraction of photons with energies below 50 keV are stopped in the chamber wall, some photons could enter the sensitive volume of the chamber and could, therefore, contribute to the activity measurement. All photons with energies below about 13 keV are stopped before they reach the sensitive volume of the chamber and, therefore, these photons do not contribute to the activity measurement.

Calibration Setting Numbers

The relationship between the response of the detector and the gain setting (relative to that for Co-60, in order for the instrument to give a direct reading of the activity) is given by:

$$G_A \equiv \frac{1}{R_A} \qquad (4)$$

The calibration setting number is linearly related to the chamber response.

All the calibrators are calibrated with certified Cobalt-60 and Cobalt-57 standard source.

A calibration setting number of 990 was assigned to Co60 and 112 was chosen for Co57.

The calibration setting number of CRC® Calibrator for radioisotope A, N_A, is given by:

$$N_A = \left(R_A - \left(1 - \frac{(R_{Co60} - R_{Co57})}{(N_{Co60} - N_{Co57})} * N_{Co60} \right) \right) * \frac{(N_{Co60} - N_{Co57})}{(R_{Co60} - R_{Co57})} \qquad (5)$$

Entering numerical values:

$$N_{Co60} = 990 \quad N_{Co57} = 112$$
$$R_{Co60} = 1.000 \quad R_{Co57} = 0.189 \pm 2\% \qquad (6)$$
$$\text{one obtains:} \quad N_A = 1076(R_A - 0.080)$$

The accuracy of the sensitivity curve and the calibration number determination was tested by calculating calibration numbers for all the radioisotope standards used for the studies of the sensitivity. The agreement between the calculated and the observed responses were all within ±3%.

The accuracy of the chamber response calculation for a particular radioisotope, hence the accuracy which can be attained by using a calculated Calibration Setting Number depends not only on the accuracy of the available primary standards used to determine Figure A1-1,

on the nuclear data, on the variation in the chamber sensitivity and electrometer gain setting, but also on the sample configuration due to low energy photon absorption.

The calibration Setting Numbers for pure and equilibrium state radioisotopes for the CRC® calibrators are listed in Appendix II of this manual. Appendix III contains tables of multiplication factors for obtaining the activity of a parent nuclide when it is not in equilibrium with the daughter nuclide. A general equation for this situation is also given in that appendix.

Since the determination of the Calibration Numbers and the calibrations (normalization) of the instrument are performed using standard reference materials issued by the NIST and/or the LMR, the Calibration Numbers for radioisotopes are given for sample configuration similar to those issued by the NIST.

All of the NIST standards, with the exception of Xe-133, were of the liquid solution form. Approximately 5 g of radioactive liquid were sealed in borosilicate glass ampoules having a diameter of about 17 mm, a length of 40 mm, and a wall thickness of 0.6 mm. The Xe-133 standard was sealed together with inactive xenon gas in a borosilicate glass ampoule having a volume of about 5 ml, a length of 45 mm, a diameter of 15 mm, and a wall thickness of 1.3 mm.

DETAILED DISCUSSIONS

Effects of the Integral Shield

The advantage of the shield is the reduction of radiation exposure to the personnel handling the radioisotopes, as well as reduction of the background effects on the activity measurements.

It is important to note, however, that if a shield is placed around or near a calibrator, the sensitivity of the ionization chamber is enhanced due to backscattering of photons by the shielding. Above about 250 keV, the scattering of photons is mainly forward and at the low energy region, attenuation of photons by the outer wall of the chamber becomes significant. For a CRC® calibrator the backscattering effects are more significant for photons of energies between 70 keV and 250 keV than photons in other energy regions.

Effects of the Container

The radioactive standard materials in the ampoules now being provided by NIST are a good approximation to an assay of a radiopharmaceutical in a plastic syringe or in a glass syringe (a wall thickness of about 1.2 mm), even for radioisotopes that decay with a significant abundance of low-energy photons.

The user should select, whenever possible, a standardized procedure, volume, and container for all radioactivity measurements. The plastic syringe is convenient since it represents the delivery vehicle to the patient in most clinical situations.

Significant errors will occur in some instances, e.g., if the radioisotope is assayed in an appreciably different material and/or wall thickness than that of the standards.

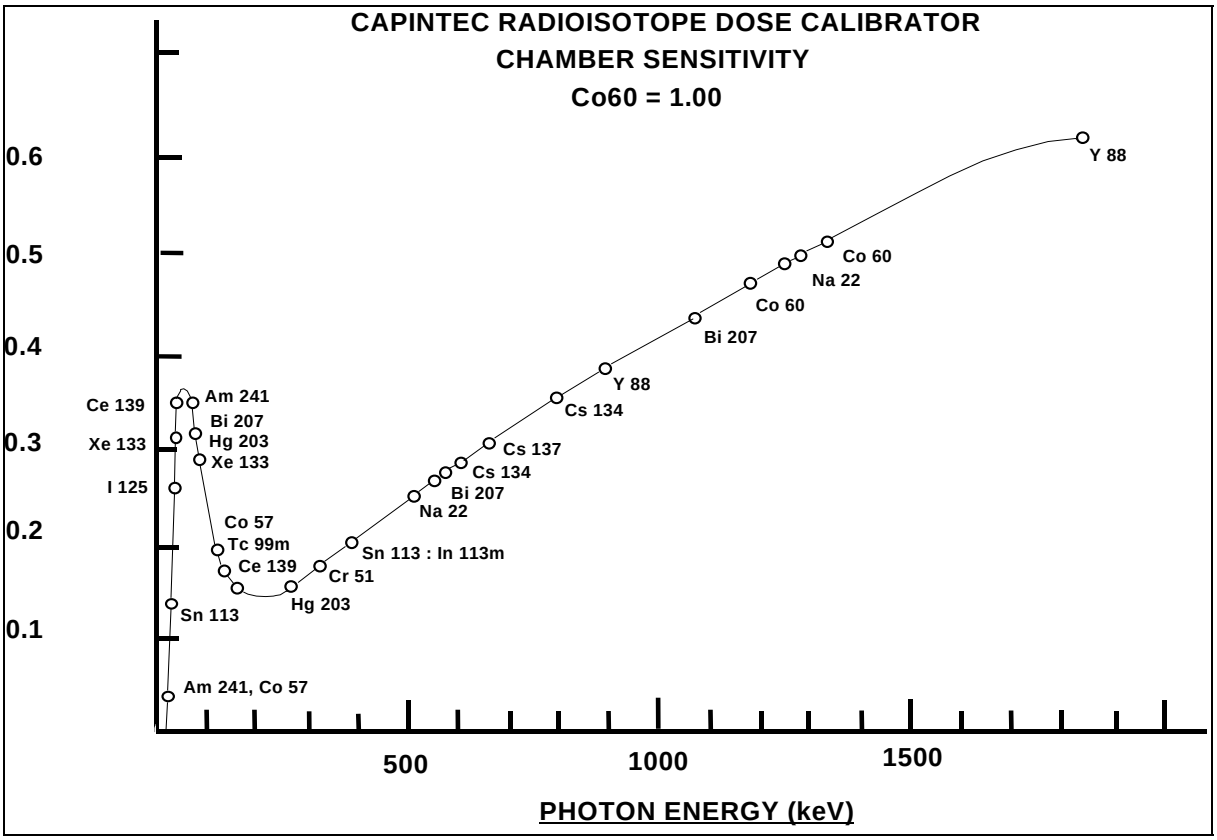
The ampoules of recently available standards from NIST are uniform. Plastic syringes also have a rather uniform wall thickness and absorption is low. However, a random sampling of 5-, 10-, 25-, 50-, and 125-ml size multi-injection dose vials from several sources indicated that the wall thickness varied randomly from 1 to 3 mm quite independently of the volume of glass vial.

The assay of radioisotopes having a significant abundance of low- energy gamma-, x-, and/or high-energy beta-ray radiation may be affected by changes in the sample configuration used to assay the radio-pharmaceutical if the samples are severely different from the standard source. In such cases, an independent check or determination of a calibration appropriate to a user's needs is advised. Fortunately, most radioisotopes can be accurately assayed independently of the sample size.

The radioisotopes most sensitive to source configuration and type of container are I-125 and Xe-133. Other radioisotopes which fall into this category are I-123, Y-169, Tl-201, and other radioisotopes that decay with significant low-energy photon emission. It is not unusual to have a required correction factor of 2 if I-125 is measured in a glass vial.

Effects of Impurities

An Ionization chamber itself does not have intrinsic energy- discrimination capability. The presence of radioisotope impurities will affect the reading of the instrument unless the effect of impurities is eliminated by photon filtration as is done with Mo-99 breakthrough in Tc-99m. However, the presence of low-level radionuclide impurity does not negate the usefulness of a radioisotope calibrator, if the user is aware of its presence and has an independently determined calibration including photons arising from the impurities.


CAPINTEC RADIOISOTOPE DOSE CALIBRATOR
CHAMBER SENSITIVITY
Co60 = 1.00
0.6
0.5
0.4
0.3
0.2
0.1
Y 88
Co 60
Na 22
Co 60
Bi 207
Y 88
Cs 134
Cs 137
Cs 134
Bi 207
Na 22
Sn 113 : In 113m
Cr 51
Hg 203
Ce 139
Tc 99m
Co 57
Sn 113
Am 241, Co 57
Ce 139
Xe 133
I 125
Am 241
Bi 207
Hg 203
Xe 133
500
1000
1500
PHOTON ENERGY (keV)

APPENDIX II

TABLE OF CALIBRATION SETTING NUMBERS

CALIBRATION SETTING NUMBERS

The Calibration Setting Numbers in Table I are applicable to the Capintec Radioisotope Calibrator only.

The CRC®-15R is a direct reading instrument. No manual multiplication or division should be performed, even if the Calibration Setting Number is followed by a multiplication sign "×" or a division sign "÷" and a number.

If the sample contains radioactive impurities, the meter indication will always be higher than the actual activity of the principal isotope. It will not, however, be the total activity of the principal isotope and the impurities.

If a Radium Needle is measured, the reading will be lower than the true activity in the needle due to the shielding effects (filtration) of the needle. To estimate the true activity in a needle, increase the reading obtained with a calibration number for Ra-226 (778) by 2% for each 0.1 mm. of platinum wall thickness. For example, add 10% to the reading for a 0.5 mm. wall platinum needle and add 20% to the reading for a 1.0 mm. wall platinum needle to estimate the true Radium activity.

ABBREVIATIONS USED IN TABLE I

Abbreviation	Meaning	Abbreviation	Meaning
eqb.	equilibrium	D	days
S	seconds	Y	years
H	hours	E	exponential, i.e.,
M	minutes		$3E5 = 3 \times 10^5$

UNCERTAINTY DUE TO SYRINGE CORRECTION

The Calibration Setting Numbers are given for approximately 5 grams of radioactive solution in a standard source ampoule made of about 0.6 mm. thick borosilicate glass. The standard radioactive source in the ampoule is, however, a good approximation for a radiopharmaceutical in a plastic syringe or a glass syringe (wall thickness about 1.2 mm.) for most radioisotopes.

In general, the attenuation of radiation by a plastic syringe is less than for the standard ampoule, while for most glass syringes, the attenuation will be greater than for the standard ampoule.

The anticipated syringe corrections are listed on the table under the column "Uncertainty Due to Syringe Correction." For example, the required correction for I-125 activity is estimated to be about, ±25%. This means that you should add 25% to the meter reading if the I-125 is in a glass syringe or subtract 25% if it is in a plastic syringe.

Since the attenuation of low energy radiation is very dependent upon the material of the container, the value given in the syringe correction column should be used mainly as a guide giving relative magnitude.

If a measurement of activity in a glass vial is anticipated, the container correction for low energy isotopes will be substantial. It could be about 3 to 5 times that for a syringe.

If no value is given in this column, the correction is not significant, except for a container differing greatly from the standard ampoule (e.g. very thick glass container, vial made of glass which contains lead, etc.).

UNCERTAINTY DUE TO PUBLISHED DATA

This is the uncertainty on the value of the activity. From calibration numbers calculated from decay data, the uncertainty given is calculated using only the reported errors on the intensity of the g and/or x-rays. For calibration numbers measured from NBS standard reference materials (known as SRM;s), the uncertainty given is the reported uncertainty on the activity of the SRM. For these numbers, the reference is given as NBS (or LMR - Laboratoire de Metrologie de la Radioactivite - France), and year of source.

HALF-LIFE

The number before the letter is the value of the half-life. The number following the letter is the reported uncertainty on the half-life.

Examples:

12.34	D1	means	12.34	days	±0.01	days
12.34	D11	means	12.34	days	±0.11	days
12.340	D1	means	12.340	days	±0.001	days
1.234	D1	means	1.234	days	±0.001	days

REFERENCES

This is the source of the data from which the calibration number was calculated. NBS or LMR means that the calibration number was obtained by measuring a standard reference material (SRM).

NM75 (Nuclear Medicine 75): L.T. Dillman and F.C. Von Der Lage, Radionuclide Decay Schemes and Nuclear Parameters for Use in Radiation-Dose Estimation. NM/MIRD Pamphlet No. 10, 1975.

ORNL76: M.J. Martin Ed., Nuclear Decay Data for Selected Radionuclides. ORNL-5114, Oak Ridge National Laboratory, March 1976.

NDT70: M.J. Martin and P.H. Blichert-Toft. Radioactive Atoms: Auger-Electrons, a -, bA, Vol. 8, Nos.1,2. October, 1970

NDS: Nuclear Data Sheets, Academic Press.

Martin: M. J. Martin. Evaluated Nuclear Data File. Nuclear Data Project. Oak Ridge National Laboratory.

NCRP-58: National Council on Radiation Protection and Measurement., Report No.58 A HANDBOOK OF RADIOACTIVITY MEASUREMENTS PROCEDURE.

NUCLIDES and ISOTOPES: Chart of the nuclides. Fourteenth Edition.
General Electric Company Nuclear Energy Operations. Rev. 1989

TABLE I

CAUTION: The calibration numbers given in this table are based upon the NIST SRM geometry (5ml of solution in glass ampoule with 0.6mm wall thickness). Listed numbers should provide an accuracy of ±5% when compared to a NIST SRM. Different source geometries (e.g. capsules, seeds, ribbons) may require geometry correction factors or different calibration numbers. However, no warranty of any kind can be made as to their accuracy, since there are many other uncontrollable factors (as well as the accuracy of the published data) involved in the determination of the overall accuracy of an assay. See previous sections of this manual for a discussion of some of the conditions under which the calibration numbers are valid.

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{7}Be	Beryllium	179 x 10			53.284 D 4	NM75	
^{11}C	Carbon	457			20.38 M 2	ORNL76	
^{13}N	Nitrogen	457			9.965 M 4	ORNL76	
^{15}O	Oxygen	462			122.24 S 14	ORNL76	
^{18}F	Fluorine	439			109.71 M 2	ORNL76	
^{22}Na	Sodium	957		1.7	2.602 Y 1	NBS73	Ref. for 0.51, 1.27 MeV
^{24}Na	Sodium	658 ÷ 2			14.959 H 4	ORNL76	
^{26}Al	Aluminum	481 ÷ 2			7.2E5 Y 3	ORNL76	
^{27}Mg	Magnesium	331			9.458 M 12	ORNL76	
^{28}Mg	Magnesium	719	3	4	20.91 H 3	ORNL76	Pure; NOTE: NM75 yields a Cal. No. of 804
^{28}Al	Aluminum	583			2.244 M 3	ORNL76	Pure
^{28}Mg	Magnesium (Eqb. ^{28}Al)	656 ÷ 2	3	4	20.91 H 3	ORNL76	Reading gives ^{28}Mg Act. in eqb. sample. Teqb after 15 minutes.
^{28}Al	Aluminum (Eqb. ^{28}Mg)	656 ÷ 2			2.244 M 3	ORNL76	Reading gives ^{28}Al Act. in eqb. sample. Teqb. after 15 minutes
^{28}Mg ^{28}Al	Magnesium Eqb. Aluminum	656	3			ORNL76	Reading gives sum of ^{28}Mg & ^{28}Al activity in equilibrium sample.
^{32}P	Phosphorus	750 × 100		1.2	14.29 D 2	NBS76	Estimation use only.
^{38}Cl	Chlorine	470		2	36.51 M 4	NDT70	
^{40}K	Potassium	520 × 10			1.28E9 Y 1	NM75	
^{41}Ar	Argon	468			1.827 H 7	ORNL76	
^{42}K	Potassium	033 or 152 × 2		3	12.36 H 1	ORNL76	
^{43}K	Potassium	430		2	22.3 H 1	ORNL76	
^{44}Sc	Scandium	938			3.927 H 8	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{44}Ti	Titanium	514	2	2	47.3 Y 12	ORNL76	
^{46}Sc	Scandium	822			83.79 D 2	ORNL76	
^{47}Ca	Calcium	373			4.536 D 2	ORNL76	Pure; ^{47}Ca decays to ^{47}Sc. Eqb. in 90 days.
^{47}Sc	Scandium	026 or 618 × 2			3.351 D 2	ORNL76	Pure; see App. II for non-eqb.
^{48}V	Vanadium	569 ÷ 2			15.974 D 3	ORNL76	
^{49}Ca	Calcium	956		2	8.72 M 2	NDT70	Pure; decays to ^{49}Sc
^{51}Cr	Chromium	100 × 10		1.25	27.702 D 4	NBS76	Ref. for 320 keV
^{52}Mn	Manganese	676 ÷ 2			5.591 D 3	ORNL76	
^{52m}Mn	Manganese	461 ÷ 2			21.1 M 2	ORNL76	Decays to ^{52}Mn
^{52}Fe	Iron	374			8.275 H 8	ORNL76	^{52m}Mn will contribute to dose.
^{54}Mn	Manganese	309			312.14 D 5	ORNL76	
^{55}Fe	Iron	374			2.72 Y 2	ORNL76	
^{55}Co	Cobalt	481		7	17.54 H	NDS76	
^{56}Co	Cobalt	648 ÷ 2			77.9 D 12	NDT70	
^{56}Ni	Nickel	844		4	6.1 D 3	NDT70	Decays to ^{56}Co; See App. II
^{56}Mn	Manganese	627		2	2.577 H 1	ORNL76	
^{57}Co	Cobalt	112		1.9	271.7 D 2	NBS76	Ref. for 122 keV Capintec Low Energy Reference.
^{58}Co	Cobalt	389			70.82 D 3	ORNL76	
^{59}Fe	Iron	430			44.51 D 2	ORNL76	
^{60}Co	Cobalt	990		1.0-NBS 1.5-LMR	5.2714 Y 5	NBS75	Ref. for 1.17, 1.33 MeV Capintec High Energy Reference
^{62}Cu	Copper	448			9.74 M 2	NM75	Pure
^{62}Zn	Zinc	217			9.22 H	NM75	Pure
^{62}Zn	Zinc (Eqb. ^{62}Cu)	760					Reading gives ^{62}Zn Act. in eqb. sample. Eqb. after 1.5 hours.
^{62}Cu	Copper (Eqb. ^{62}Zn)	745					Reading gives ^{62}Cu Act. in eqb. sample. Eqb. after 1.5 hours.
^{62}Zn ^{62}Cu	Zinc Eqb. Copper	333				NM75	Reading gives sum of ^{62}Zn & ^{62}Cu activity in equilibrium sample.

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{64}Cu	Copper	015 or 115 × 2			12.701 H 2	ORNL76	
^{65}Zn	Zinc	172			243.9 D 1	ORNL76	
^{66}Ga	Gallium	903		2	9.40 H 7	ORNL76	
^{67}Cu	Copper	052		4	2.575 D 3	ORNL76	
^{67}Ga	Gallium	100		1.4	3.261 D 1	NBS78	
^{68}Ga	Gallium	416			68.0 M 2	ORNL76	
^{69m}Zn	Zinc	143			13.76 H 3	ORNL76	
^{72}As	Arsenic	795			26.0 H 1	ORNL76	
^{72}Ga	Gallium	470 ÷ 2		2	14.10 H 1	ORNL76	
^{73}As	Arsenic	324 × 10	4	3	80.30 D 6	ORNL76	
^{73}Se	Selenium	748			7.15 H 8	ORNL76	Decays to ^{73}As.
^{74}As	Arsenic	304		5	17.78 D 3	ORNL76	
^{75}Se	Selenium	258		2.5	119.8 D 1	NBS75	
^{76}As	Arsenic	110		6	26.32 H 7	ORNL76	
^{77}As	Arsenic	481 × 100		26	38.8 H 3	ORNL76	Estimation use only.
^{77}Br	Bromine	091		3	56 H 2	ORNL76	
^{79}Kr	Krypton	050		3	35.04 H 10	ORNL76	
^{81}Rb	Rubidium	174			4.58 H	NM75	Pure
^{81m}Kr	Krypton	915 × 10			13 S 1	NM75	Pure
^{81}Rb / ^{81m}Kr	Rubidium / Eqb. / Krypton	270				NM75	Reading gives act. of ^{81}Rb or ^{81m}Kr in equilibrium sample. Eqb. after 2 minutes.
^{82}Br	Bromine	536 ÷ 2		2	35.34 H 2	ORNL76	
^{82}Rb	Rubidium	504			1.273 M 2	NM75	
^{84}Rb	Rubidium	347			32.77 D 4	NM75	
^{85m}Kr	Krypton	065		1	4.480 H 8	ORNL76	Decays to ^{85}Kr
^{85}Kr	Krypton	031 × 100		2	10.72 Y 1	ORNL76	
^{85}Sr	Strontium	193		1.0	64.854 D 3	NBS75	
^{86}Rb	Rubidium	411 × 10			18.64 D 2	ORNL76	
^{86}Y	Yttrium	711 ÷ 2			14.74 H 2	ORNL76	
^{86}Zr	Zirconium	167	18	3	16.5 H 1	ORNL76	
^{87}Kr	Krypton	250		6	76.3 M 5	ORNL76	
^{87m}Sr	Strontium	095			2.805 H 3	ORNL76	Pure
^{87}Y	Yttrium	170		1	80.3 H 3	ORNL76	Pure

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{87}Y	Yttrium (Eqb. ^{87m}Sr)	357				ORNL76	Reading gives ^{87}Y Act. in eqb. sample. Eqb. after 18 hours.
^{87}Y ^{87m}Sr	Yttrium Eqb. Strontium	341		2		ORNL76	Reading gives sum of ^{87}Y & ^{87m}Sr activity in equilibrium sample.
^{88}Rb	Rubidium	189		14	17.8 M 1	ORNL76	
^{88}Y	Yttrium	465 ÷ 2		1.8	106.61 D 2	NBS73	
^{89}Rb	Rubidium	768		1	15.2 M 1	ORNL76	
^{90}Y	Yttrium	48 × 10			64.0 H 1	NIST92	Estimation use only.
^{91}Y	Yttrium	850 × 10			58.5 D 4	NDT70	Almost pure β decay. Estimation use only.
^{94}Nb	Niobium	673			2.03E4 Y 16	ORNL76	
^{95}Nb	Niobium	285			34.97 D 1	NDT70	Pure
^{95}Zr	Zirconium	271			64.02 D 5	NDT70	Pure
^{95}Zr ^{95m95}Nb	Zirconium Eqb. Niobium	145			^{95m}Nb 3.61 D 1	NDT70	Reading gives sum of ^{95m}Nb & ^{95}Nb activity in equilibrium sample. Eqb. after 2 years.
^{97}Nb	Niobium	249			72.1 M 7	ORNL76	
^{97}Zr ^{97m}Nb	Zirconium Eqb. Niobium	341		12	16.90 H 5	ORNL76	Reading gives sum of ^{97}Zr & ^{97m}Nb activity in equilibrium sample. Eqb. after 10 minutes.
^{97m}Nb	Niobium	271			60 S 1	ORNL76	
^{97}Ru	Ruthenium	116	15	2	2.9 D 1	ORNL76	Decays to ^{97m}Tc
^{97m}Tc	Technetium	256 × 10	65		91.0 D	NM75	Estimation use only.
^{99}Mo	Molybdenum (in Std. Mo Kit)	080 × 5 or 246× 10 or 030 × 3.5				NTS78	
^{99}Mo	Molybdenum (in CAP-MAC)	030 × 4 or 204 × 10				NBS78	
^{99}Mo	Molybdenum (in MAC-S)	030 × 4 or 204 × 10				NBS78	
^{99}Mo	Molybdenum (Eqb. ^{99m}Tc)	165	2	1.9	65.92 H 2	NBS78	
^{99m}Tc	Technetium	080	2	2.1	6.007 H 1	NBS76	
^{99m}Tc	Technetium (in CAP-MAC)	042		2.1	6.007 H 1	NBS76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{99m}Tc	Technetium (Eqb. ^{99}Mo)	175	2			NBS78	
^{99}Mo	Molybdenum						Reading gives sum of ^{99}Mo & ^{99m}Tc activity in equilibrium sample.
	Eqb.	145	2			NBS78	
^{99m}Tc	Technetium						
^{103}Pd	Palladium	562 × 10	50	4	16.97 D 2	ORNL76	Pure
^{103}Pd	Palladium						Reading gives sum of ^{103}Pd & ^{103m}Rh activity in equilibrium sample. Eqb. after 9 hours.
	Eqb.	634 × 10	50	5		ORNL76	
^{103m}Rh	Rhodium						
^{103m}Rh	Rhodium	631 × 100	50	5	56.114 M 6	ORNL76	
^{103}Ru	Ruthenium	165	50	3	39.26 D 2	ORNL76	
^{103}Ru	Ruthenium						Reading gives sum of ^{103}Ru & ^{103m,}Rh activity in equilibrium sample. Eqb. after 9 hours.
	Eqb.	172	50			ORNL76	
^{103m}Rh	Rhodium						
^{106}Ru	Ruthenium (Eqb. ^{106}Rh)	027 or 140 × 2			369 D 2	NDT70	Reading gives ^{106}Ru Act. in eqb. sample. Eqb. after 5 minutes.
^{106}Ru	Ruthenium						Reading gives sum of ^{106}Ru & ^{106}Rh activity in equilibrium sample.
	Eqb.	480 × 10			369 D 2	NDT70	
^{106}Rh	Rhodium						
^{108m}Ag	Silver	830	3		127 Y 21	ORNL76	
^{108}Ag	Silver	099 × 10	6	15	2.37 M 1	ORNL76	Large β contribution.
^{109}Cd	Cadmium	047 or	40	4	462.6 D 4		Reading gives act of ^{109}Cd, ^{109m}Ag, or Total Act. in eqb. sample. Eqb. after 6 minutes.
	Eqb.	180 × 2					
^{109m}Ag	Silver				39.8 S		
^{109}Pd	Palladium				13.427 H 14		Reading gives act of ^{109}Pd, ^{109m}Ag, or Total Act. in eqb. sample. Eqb. after 6 minutes.
	Eqb.	435 × 10			39.8 S		
^{109m}Ag	Silver						
^{110m}Ag	Silver	554 ÷ 2		2	249.8 D 1	ORNL76	
^{111}Ag	Silver	054 × 10		30	7.45 D 1	ORNL76	
^{111}In	Indium	303	10	1.36	2.805 D 1	NBS77	
^{113}Sn	Tin	022 or	35	5	115.08 D 3	MARTIN77	For pure ^{113}Sn.
		129 × 2					
^{113m}In	Indium	076	7	2	1.658 H 1		Separated for pure ^{113m}In.
^{113}Sn	Tin						Reading gives act. of ^{113}Sn, ^{113m}In, or Total Act. in eqb. sample. Eqb. after 15 hours.
	Eqb.	180	15	3.2	NBS73,77		
^{113m}In	Indium						
^{115m}In	Indium	058	15	2	4.486 H 4	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{116m}In	Indium	974		3	54.15 M 6	ORNL76	
^{117m}Sn	Tin	180	15	2	13.61 D 4	ORNL76	
^{117}Sb	Antimony	082	3	2	2.80 H 1	ORNL76	
^{119m}Sn	Tin	657 × 10	35	4	293.0 D 13	ORNL76	
^{121m}Te	Tellurium	187	12	9	154 D 7	ORNL76	Pure
^{121}Te	Tellurium	373	10	3	17 D 1	ORNL76	Pure
^{121m}Te ^{121}Te	Tellurium Eqb. Tellurium	645					Reading gives act. of ^{121m}Te or ^{121}Te in eqb. sample. Eqb. in 120 days. See App. II for non-eqb. samples.
^{121m}Te ^{121}Te	Tellurium Eqb. Tellurium	572					Reading gives sum of ^{121m}Te or ^{121}Te in eqb. sample.
^{122}Sb	Antimony	146		6	2.70 D 1	ORNL76	
^{123}I	Iodine	277	15	1.9	13.221 H 3	NBS77	Ref. for 28 keV x-ray.
^{123m}Te	Tellurium	177	12		119.7 D 1	NDT70	
^{124}Sb	Antimony	720			60.20 D 3	ORNL76	
^{124}I	Iodine	570	5		4.18 D 2	ORNL76	
^{125}I	Iodine	319	25	1.45	59.6 D 2	NBS76	
^{125}Sb	Antimony	289	10		2.758 Y 1	NDT70	Pure
^{125}Sb	Antimony (Eqb. ^{125m}Te)	371	12		2.758 Y 1	NDT70	Reading gives ^{125}Sb Act. in eqb. sample. Eqb. after 1 year.
^{125}Sb ^{125m}Te	Antimony Eqb. Tellurium	364	12			NDT70	Reading gives sum of ^{125}Te and ^{125m}Te in eqb. sample. See App. II for non-eqb. activity.
^{125m}Te	Tellurium	259	25		57.40 D 5	NDT70	
^{126}I	Iodine	240	10	18	13.02 D 7	ORNL76	
^{127}Xe	Xenon	371	12	5	36.4 D 1	ORNL76	
^{129m}Te	Tellurium	817 × 10	20	5	33.6 D 1	ORNL76	Pure
^{129}Te	Tellurium	679 × 10	15	13	69.6 M 2	ORNL76	Pure
^{129m}Te ^{129}Te	Tellurium Eqb. Tellurium	054					Reading gives act. of ^{129m}Te or total act. in eqb. sample. Eqb. in 10 hours.
^{129}Cs	Cesium	397	15	20	32.06 H 6	ORNL76	NM75 gives 488
^{129}I	Iodine	166	20		1.57E7 Y 4	ORNL76	
^{129m}Xe	Xenon	362	20	3	8.0 D 2	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{130}I	Iodine	984			12.36 H 1	ORNL76	
^{131}I	Iodine	151		1.65	8.021 D 1	NBS76	Decays to ^{131m}Xe. 1.1% feeding.
^{131m}Xe	Xenon	089	20	3	11.9 D 1	ORNL76	
^{131}Cs	Cesium	148	20	3	9.69 D 1	ORNL76	
^{131}Ba	Barium	505	10	7	11.8 D 2	ORNL76	
^{132}Te	Tellurium	315	10	5	76.3 H 2	ORNL76	Pure
^{132}I	Iodine	999			2.30 H 3	ORNL76	Pure
^{132}Te	Tellurium (Eqb. ^{132}I)	675 ÷ 2					Reading gives ^{132}Te Act. in eqb. sample. Eqb. after 1 day.
^{132}I	Iodine (Eqb. ^{132}Te)	653 ÷ 2					Reading gives ^{132}I Act. in eqb. sample.
^{132}Te ^{132}I	Tellurium Eqb. Iodine	663				ORNL76	Reading gives sum of ^{132}Te and ^{132}I in eqb. sample.
^{132}Cs	Cesium	485	10	2	6.475 D 10	ORNL76	
^{133}I	Iodine	225			20.8 H 1	ORNL76	Decays to ^{133m}Xe.
^{133m}Xe	Xenon	100	20	3	2.19 D 1		Decays to ^{133}Xe. See App. II.
^{133}Xe	Xenon	188	12	1.95	5.243 D 1	NBS76	
^{133m}Ba	Barium	132	12	3	38.9 H 1	ORNL76	Decays to ^{133}Ba.
^{133}Ba	Barium	591	10	3	10.5 Y 1	ORNL76	
^{134}Te	Tellurium	533	3	6	41.8 M 8	ORNL76	
^{134m}Cs	Cesium	037 or 160 × 2	15		2.91 H	NM75	Decays to ^{134}Cs.
^{134}Cs	Cesium	726		2.3	2.065 Y 1	NBS73	
^{135m}Xe	Xenon	181	3		15.29 M 3	ORNL76	Decays to ^{135}Xe. See App. II.
^{135}Xe	Xenon	085	2		9.09 H 1	ORNL76	
^{135m}Ba	Barium	130	15	4	28.7 H 2	ORNL76	
^{136}Cs	Cesium	489 ÷ 2		4	13.1 D 1	ORNL76	
^{137}Cs ^{137m}Ba	Cesium Eqb. Barium	220		2.0	30.0 Y 2 2.553 M 1	NBS73	Ref: 661.6 & 32.9 keV. Reading gives ^{137}Cs or Total Activity of eqb. sample. Often referred to as "Cs-137" Source.
^{139}Ba	Barium	445 × 10	5	12	82.8 M 2	ORNL76	
^{139}Ce	Cerium	352	5	2.6	137.64 D 2	NBS73	Ref: 36.8 keV
^{141}Ce	Cerium	061	5	5	32.50 D 1	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{142}Pr	Praseodymium	226 × 10		14	19.13 H 4	ORNL76	
^{144}Pr	Praseodymium	137 × 10		5	17.28 M 5	ORNL76	Estimation use only. β dominant.
^{144}Ce ^{144}Pr	Cerium Eqb. Praseodymium	387 × 10	5	2.8	285.0 D 1	NBS73	Ref: 36.7 & 133.5 keV. Reading gives sum of ^{144}Ce & ^{144}Pr Act. in equilibrium sample. Eqb. after 2 hours.
^{145}Pm	Promethium	207	10	3	17.7 Y 4	ORNL76	
^{147}Nd	Neodymium	213	5	4	10.98 D 1	ORNL76	
^{157}Dy	Dysprosium	424	5		8.1 H 1	NM75	
^{169}Yb	Ytterbium	948	3	2.5	32.03 D 1	NBS78	
^{171}Tm	Thulium	292 × 100	4		1.92 Y 1	NM75	
^{175}Yb	Ytterbium	308 × 10	2	13	4.19 D 1	ORNL76	
^{177}Lu	Lutetium	450 × 10	2	7	6.71 D 1	ORNL76	
^{181}Hf	Hafnium	387		6	42.4 D 1	ORNL76	
^{181}W	Tungsten	165	3	11	121.2 D 3	ORNL76	
^{188}W	Tungsten	111 × 100			69.4 D 5	NM75	Decays to ^{188}Re. Eqb. after 7 days. See App. II
^{188}Re	Rhenium	496 × 10			16.98 H 2	NM75	
^{188}W	Tungsten (Eqb. ^{188}Re)	522 × 10					Reading gives ^{188}W Act. in eqb. sample. Eqb. after 5 days.
^{188}Re	Rhenium (Eqb. ^{188}W)	516 × 10					Reading gives ^{188}Re Act. in eqb. sample.
^{188}W ^{188}Re	Tungsten Eqb. Rhenium	217 × 10					Reading gives sum of ^{188}W & ^{188}Re activity in equilibrium sample.
^{190m}Os	Osmium	858			9.90 M	NM75	
^{191}Os	Osmium	250	2	13	15.4 D 2	ORNL76	
^{192}Ir	Iridium	408			73.83 D 1	NDS73	
^{194}Ir	Iridium	469 × 10		18	19.15 H 3	ORNL76	
^{197}Pt	Platinum	686 × 10	2	6	18.3 H 3	ORNL76	
^{197}Hg	Mercury	197	2	2.9	64.1 H 1	NBS76	Ref. for 70 & 77 keV.
^{198}Au	Gold	149		1.65	2.696 D 2	NBS78	
^{199}Au	Gold	053		6	3.139 D 7	ORNL76	
^{201}Tl	Thallium	205	2	2.0	72.91 H 2	NBS76	
^{203}Hg	Mercury	093		1.1	46.60 D 1	NBS73	
^{203}Pb	Lead	344		2	51.88 H 1	ORNL76	

Radioisotopes		Calibration Setting Number	Uncertainty Due to Syringe Corr. %	Uncertainty Due to Published Data %	Half-Life (NCRP-58)	Ref.	Comments
^{204}Tl	Thallium	420 × 100	2	2	3.78 Y 2	NDT70	
^{207}Bi	Bismuth	846		1.7	32.2 Y 9	NBS73	Ref. for 1064, 569.7, 76.7, & 1772 keV.
^{208}Tl	Thallium	571 ÷ 2			3.053 M 4	NM75	
^{212}Pb	Lead	101			10.64 H 1	NM75	Decays to ^{212}Bi. Eqb. after 1 hr. See App. II.
^{212}Bi	Bismuth	489 × 10			60.55 M 6	NM75	
^{212}Pb	Lead (Eqb. ^{212}Bi)	158					Reading gives ^{212}Pb Act. in eqb. sample. Eqb. after 8 hours.
^{212}Bi	Bismuth (Eqb. ^{212}Pb)	135					Reading gives ^{212}Bi Act. in eqb. sample.
^{212}Pb	Lead	030 or					Reading gives sum of 212Pb & 212Bi activity in equilibrium sample.
	Eqb.	146 × 2					
^{212}Bi	Bismuth						
^{224}Ra	Radium	646 × 100			3.66 D 4	NM75	
^{226}Ra	Radium + chain of daughters	778		0.5	1600 Y 7	NBS73	Reading in grams. Commonly referred to as "Radium "Source. 1.025 g/Ci of Ra-226. See explanation of table entries in appendix I.
^{239}Np	Neptunium	147		6	2.355 D 4	ORNL76	
^{241}Am	Americium	055	4	1	432.2 Y 5	LMR69	Ref. for 59.5 & 14 keV.

APPENDIX III

MULTIPLICATION FACTORS FOR NON-EQUILIBRIUM RADIOISOTOPES

The activity in a non-equilibrium sample can be determined by using the following equation:

$$\text{Activity of "A"} = \frac{\text{Meter Reading with Cal. Number for Pure "A"}}{1 + F\frac{T_A}{T_A - T_B}\left[1 - \exp\left(-\frac{T_A - T_B}{T_A \times T_B} \times t \times 1n2\right)\right]\frac{R_B}{R_A}}$$

where “A” and “B” are parent and daughter nuclide respectively, T's are half lives, and R_A and R_B are the chamber responses to the isotopes A and B, “t” is the elapsed time after the pure parent isotope was produced, and “F” is the decay branching ratio.

The chamber response,”R,” may be obtained from the calibration number “N,” using the following equation:

$$R = \frac{N}{1075.8} + 0.0797$$

When the half-life of the parent nucleus (T_A) is much shorter than that of the daughter nucleus (T_R), the parent decays down to the daughter. After about $10 \times T_A$, we can assume that only the daughter is left (except if the original activity of the parent was exceptionally high). The equation above for the Activity of “A” can be used to obtain the activity of the parent while it has measurable activity.

Multiplication factors obtained by using the equation are given in the following tables for selected isotopes.

MULTIPLICATION FACTORS FOR Ca47 ACTIVITY MEASUREMENTS

Use a Calibration Number of 373 and a multiplication factor as indicated in the following table to obtain Ca47 activity at time "t" days after an initially pure source of Ca47 is obtained.

Ca47

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	12	0.672
1	0.950	14	0.648
2	0.906	16	0.627
3	0.869	18	0.609
4	0.836	20	0.594
5	0.806	25	0.566
6	0.781	30	0.545
7	0.757	40	0.519
8	0.737	50	0.496
9	0.718	100	0.485
10	0.701	150	0.484

MULTIPLICATION FACTORS FOR Ni56 ACTIVITY MEASUREMENTS

Use a Calibration Number of 844 and a multiplication factor as indicated in the following table to obtain Ni56 activity at time "t" days after an initially pure source of Ni56 is obtained.

Ni56

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	9	0.824
1	0.985	10	0.799
2	0.969	12	0.745
3	0.952	15	0.659
4	0.934	20	0.508
5	0.915	25	0.366
6	0.894	30	0.249
7	0.872	40	0.101
8	0.849	60	0.013

MULTIPLICATION FACTORS FOR Zn62 ACTIVITY MEASUREMENTS

Use a Calibration Number of 217 and a multiplication factor as indicated in the following table to obtain Zn62 activity at time "t" minutes after an initially pure source of Zn62 is obtained.

Zn62

t [minutes]	Multiplication Factor	t [minutes]	Multiplication Factor
0	1.000	45	0.368
10	0.526	60	0.361
20	0.425	75	0.359
30	0.389	90	0.358

MULTIPLICATION FACTORS FOR Y87 ACTIVITY MEASUREMENTS

Use a Calibration Number of 170 and a multiplication factor as indicated in the following table to obtain Y87 activity at time "t" hours after an initially pure source of Y87 is obtained.

Y87

t [hours]	Multiplication Factor	t [hours]	Multiplication Factor
0	1.000	5	0.664
0.25	0.960	6	0.644
0.50	0.926	8	0.618
0.75	0.893	10	0.602
1.00	0.866	12	0.593
1.5	0.820	18	0.582
2.0	0.784	24	0.580
3.0	0.729	48	0.579
4.0	0.691	∞	0.579

MULTIPLICATION FACTORS FOR Zr95 ACTIVITY MEASUREMENTS

Use a Calibration Number of 271 and a multiplication factor as indicated in the following table to obtain Zr95 activity at time "t" days after an initially pure source of Zr95 is obtained.

Zr95

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	40	0.592
2	0.961	50	0.548
4	0.925	60	0.513
6	0.893	80	0.462
8	0.863	100	0.426
10	0.836	150	0.374
15	0.776	200	0.347
20	0.727	300	0.322
25	0.685	600	0.309
30	0.650	∞	0.308

MULTIPLICATION FACTORS FOR Te121m ACTIVITY MEASUREMENTS

Use a Calibration Number of 187 and a multiplication factor as indicated in the following table to obtain Te121m activity at time "t" days after an initially pure source of Te121m is obtained.

Te121m

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	40	0.437
1	0.943	50	0.415
2	0.895	60	0.401
5	0.782	70	0.392
10	0.661	80	0.386
15	0.586	90	0.382
20	0.535	100	0.379
25	0.499	120	0.376
30	0.472	140	0.374

MULTIPLICATION FACTORS FOR Sb125 ACTIVITY MEASUREMENTS

Use a Calibration Number of 289 and a multiplication factor as indicated in the following table to obtain Sb125 activity at time "t" days after an initially pure source of Sb125 is obtained.

Sb125

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	90	0.878
10	0.977	120	0.861
20	0.958	150	0.849
30	0.941	180	0.841
40	0.927	360	0.824
50	0.914	540	0.822
60	0.903	∞	0.821

MULTIPLICATION FACTORS FOR Te129m ACTIVITY MEASUREMENTS

Use a Calibration Number of 817 and a multiplication factor as indicated in the following table to obtain Te129m activity at time "t" hours after an initially pure source of Te129m is obtained.

Te129m

t [hours]	Multiplication Factor	t [hours]	Multiplication Factor
0	10.0	6	6.55
1	8.04	8	6.50
2	7.25	10	6.49
4	6.701	12	6.48
			Equilibrium

MULTIPLICATION FACTORS FOR Te132 ACTIVITY MEASUREMENTS

Use a Calibration Number of 315 and a multiplication factor as indicated in the following table to obtain Te132 activity at time "t" hours after an initially pure source of Te132 is obtained.

Te132

t [hours]	Multiplication Factor	t [hours]	Multiplication Factor
0	1.000	4	0.342
0.25	0.836	5	0.318
0.50	0.725	10	0.275
1.00	0.586	15	0.266
2.00	0.447	20	0.265
3.00	0.380	24	0.264
			Equilibrium

MULTIPLICATION FACTORS FOR Xe133m ACTIVITY MEASUREMENTS

Use a Calibration Number of 100 and a multiplication factor as indicated in the following table to obtain Xe133m activity at time "t" days after an initially pure source of Xe133m is obtained.

Xe133m

t [days]	Multiplication Factor	t [days]	Multiplication Factor
0	1.000	4	0.465
1	0.824	5	0.385
2	0.680	10	0.151
3	0.562	20	0.024

MULTIPLICATION FACTORS FOR Xe135m ACTIVITY MEASUREMENTS

Use a Calibration Number of 181 and a multiplication factor as indicated in the following table to obtain Xe135m activity at time "t" minutes after an initially pure source of Xe135m is obtained.

Xe135m

t [minutes]	Multiplication Factor	t [minutes]	Multiplication Factor
0	1.000	60	0.807
10	0.990	75	0.676
20	0.975	90	0.514
30	0.952	120	0.217
45	0.897	180	0.019

MULTIPLICATION FACTORS FOR W188 ACTIVITY MEASUREMENTS

Use a Calibration Number of 111 and a multiplication factor as indicated in the following table to obtain W188 activity at time "t" hours (or days) after an initially pure source of W188 is obtained.

W188

t [hours]	Multiplication Factor	t [days]	Multiplication Factor
0	100.0	1	5.09
1	45.6	2	3.75
2	29.9	3	3.40
4	18.2	4	3.30
6	13.4	5	3.26
12	8.0	6	3.25
18	6.0	7	3.24

MULTIPLICATION FACTORS FOR Pb212 ACTIVITY MEASUREMENTS

Use a Calibration Number of 101 and a multiplication factor as indicated in the following table to obtain Pb212 activity at time "t" hours after an initially pure source of Pb212 is obtained.

Pb212			
t [hours]	Multiplication Factor	t [hours]	Multiplication Factor
0	1.000	5	0.772
0.5	0.924	6	0.768
1.0	0.875	7	0.766
2.0	0.820	8	0.765
3.0	0.793	9	0.765
4.0	0.779	10	0.764 Equilibrium

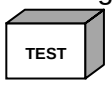
APPENDIX IV

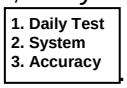
OPERATIONAL SUMMARY

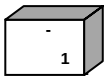
Thank you for choosing CAPINTEC. This “Start-Up” aid is designed to allow you to use the CRC-15R to perform immediate nuclide measurements.

QUALITY CONTROL & DAILY TESTS

Prior to making any activity measurements, Daily Tests must be performed.

Press 

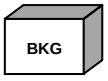
. You will see this screen: 

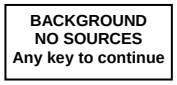
. Select Daily Test by pressing 

The **Daily Tests** include **Auto Zero**, **Background Adjustment**, **System Test**, **Data Check**, and **Constancy**. You will be required to perform your normal or manual Accuracy and Constancy tests if you have not entered your **Test Source** data in the CRC®-15R. To enter **Test Source** data, see CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING TEST SOURCE DATA.

BACKGROUND ADJUSTMENT

Background adjustment is performed automatically in the Daily Test sequence. It can also be performed by pressing the Background key.

To perform a Background Adjustment, press 

. You will see the following screen: 

. Make sure that no sources are in the vicinity of the chamber. Press any key, other than the **HOME** key, to begin. At the end of the measuring period, you will see the message “OK - ENTER to accept”. Press the **ENTER** key. The background value will be stored and automatically subtracted from all measurements.

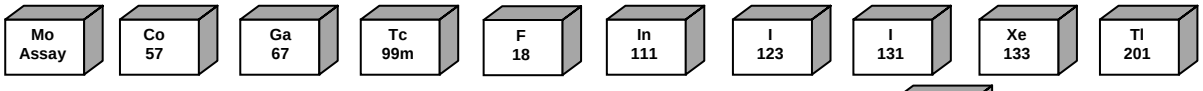
MEASURING NUCLIDE ACTIVITY

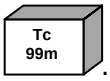
To measure the activity of a sample, simply place the sample in the dipper, lower it into the well, and select the nuclide from the keypad.

SELECTING A NUCLIDE FOR MEASUREMENT

When measuring the activity of a nuclide, you must indicate the nuclide being measured. This can be accomplished in four (4) simple ways:

1. **PRE-SET KEYS:** You can select from 10 pre-defined keys. Each key is labeled to indicate the corresponding nuclide as shown below.

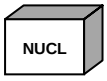


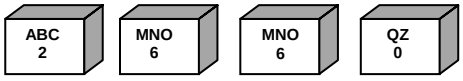
Example: Measuring **Tc99m**. Place the sample in the well and press 

. The activity for Tc99m is automatically displayed.

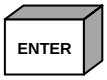
2. **USER DEFINED KEYS:** The CRC®-15R has 4 user defined keys. You can assign nuclides to these keys. (See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: USER KEY ASSIGNMENT)

3. **NUCLIDE KEY:** The Nuclide Key allows you to select a nuclide from the list of 85 nuclides that have been stored in the memory. Simply press the **NUCL** key and use the keypad to specify the nuclide. After selecting the values press the **ENTER** key.

Example: Co60 Press 

. Press 

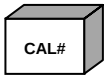
.

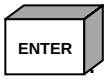
Press 

.

4. **CALIBRATION NUMBERS:** To measure the activity of a nuclide that is not stored in the memory, pre-set keys, or user defined keys, press the **CAL#** key, enter the calibration number for the nuclide, and press the **ENTER** key. The activity can then be measured. Simply place the sample in the chamber.

Note: *Calibration numbers are listed in Appendix II.*

Example: Press 

. Enter the calibration number. Press 

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FUTURE ACTIVITY

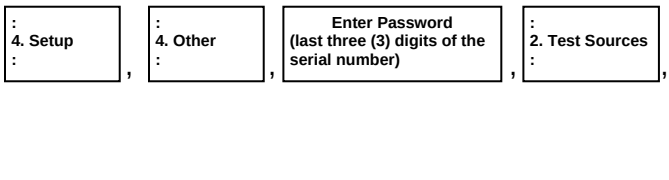
The CRC®-15R has a special feature that allows you to automatically determine the activity of a sample at some point in the future.

Example: Press TIME. Enter the new time & date in the 24 hour format.

Press ENTER. The "FUTURE" activity is displayed.

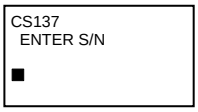
ENTER TEST DATA (See: CHAPTER 5: SYSTEM INITIALIZATION, SECTION: ENTERING TEST SOURCE DATA)

The Test Data must be entered from the main Utility Menu. To access this menu, press HOME to get to the Chamber measurement screen. Press UTIL to display the Utilities Menu. Press



.

If the Test Source data has been entered in the system, verify that these are the dates from your Cs137 Test Source and press **Y**. Press **N** if the dates are incorrect or if no source data has been entered in the system. The system then displays:



Input the serial number of the Test Source and press **ENTER**. Input the Calibration Day and press **ENTER**. Input the Calibration Activity and press **ENTER**. Answer (**Y**)es or (**N**)o to "USE FOR DAILY?".

The system will display the inserted data. Verify the data and confirm with **Y**. To correct any errors, press **N**.

Press HOME. this brings you back to the Measurement Screen.

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NEW PRODUCT WARRANTY

Conditions and Limitations

CAPINTEC warrants our products to be free from defects in material and workmanship for a period of 12 months after delivery to the original buyer (unless indicated otherwise). Our obligation under this warranty is limited to servicing or adjusting products returned to our factory for that purpose promptly upon any claim under this warranty, provided our examination discloses to our satisfaction that the affected parts were originally defective and have not been subjected to misuse, abuse, mishandling or improper operation. This warranty extends to every part of the product except batteries, fuses, ink, magnetic storage media, toner, transistors, tubes or any other normally consumable item. In no event shall we liable for transportation, installation, adjustment or any other expenses which may arise in connection with such products or their servicing or adjustment.

This warranty is expressly in lieu of any other express or implied warranties, and we make no warranty that the products sold herein are merchantable or are suitable for any particular purpose. The benefits of this warranty shall extend only to the buyer and to none other. We shall have no liability of any nature arising out of the use or application of the product in conformity with this warranty. If the product shall fail to perform in conformity with the warranty made herein, we shall be liable solely for the repair and replacement of the product as provided hereinabove, and shall have no other liability in respect of such failure or performance, or any consequences therefrom, including, without limitation, business impairment or loss, personal injury or property damage.

No agent, employee, or representative of ours has any authority to bind us to any representation or warranty concerning the product sold herein, and unless a representation or warranty made by an agent, employee or representative is specifically included herein, it shall not be enforceable by the buyer. No waiver, alteration or modification of the foregoing conditions shall be valid, unless made in writing and signed by an executive officer of our corporation.

CAPINTEC, INC.

DECLARATION OF CONFORMITY
THE EC DIRECTIVE

We, Capintec, Inc.
540 Alpha Drive
Pittsburgh, PA 15238
Phone: 412-963-1988
Fax: 412-963-0610

declare under our sole responsibility that the product CRC-15R RADIOISOTOPE DOSE CALIBRATOR (including use with Okidata Model 320, Epson Roll and Epson Slip printers) to which this declaration relates is in conformity with the Medical Device Directive 93/42/EEC.

This product is in conformity with the following standards or other normative documents following:

1. EN60601-1
2. IEC60601-1-1
3. EN60601-1-2
4. IEC60601-1-4

The Technical Construction File is maintained at:
Capintec, Inc.
540 Alpha Drive
Pittsburgh, PA 15238
Phone: 412-963-1988
Fax: 412-963-0610

The authorized representative located within the Community is:
Aries
44 bis, Bd Felix Faure
92323 Chatillion Cedex

Date of issue: 2/1/03

Place of issue:
Capintec, Inc.
540 Alpha Drive
Pittsburgh, PA 15238

Mary Anne Dell

Mary Anne Dell, Vice President & General Manager